Preparing Image Data for Machine Learning

Janani Ravi
CO-FOUNDER, LOONYCORN
www.loonycorn.com

Overview

Representing images as feature vectors

Single channel and multi-channel image data

Extracting patches from images

Learning sparse codings using dictionary learning

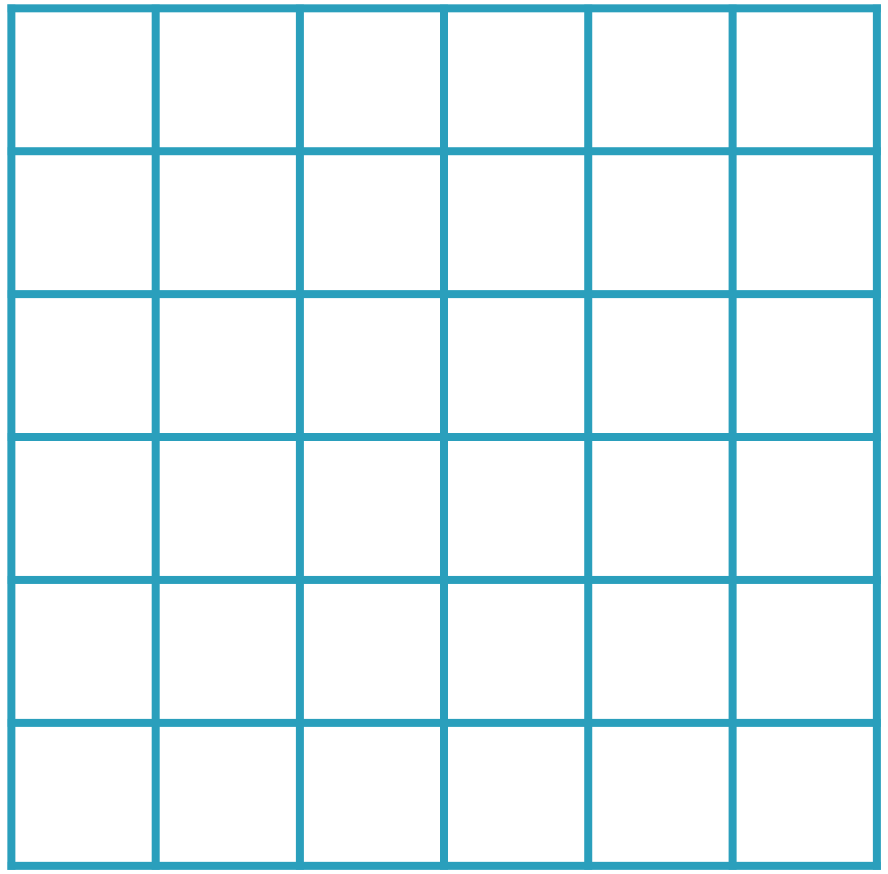
Reconstructing images from patches

Representing images using connectivity graphs

Encoding Image Data in Numeric Form

Images as Matrices

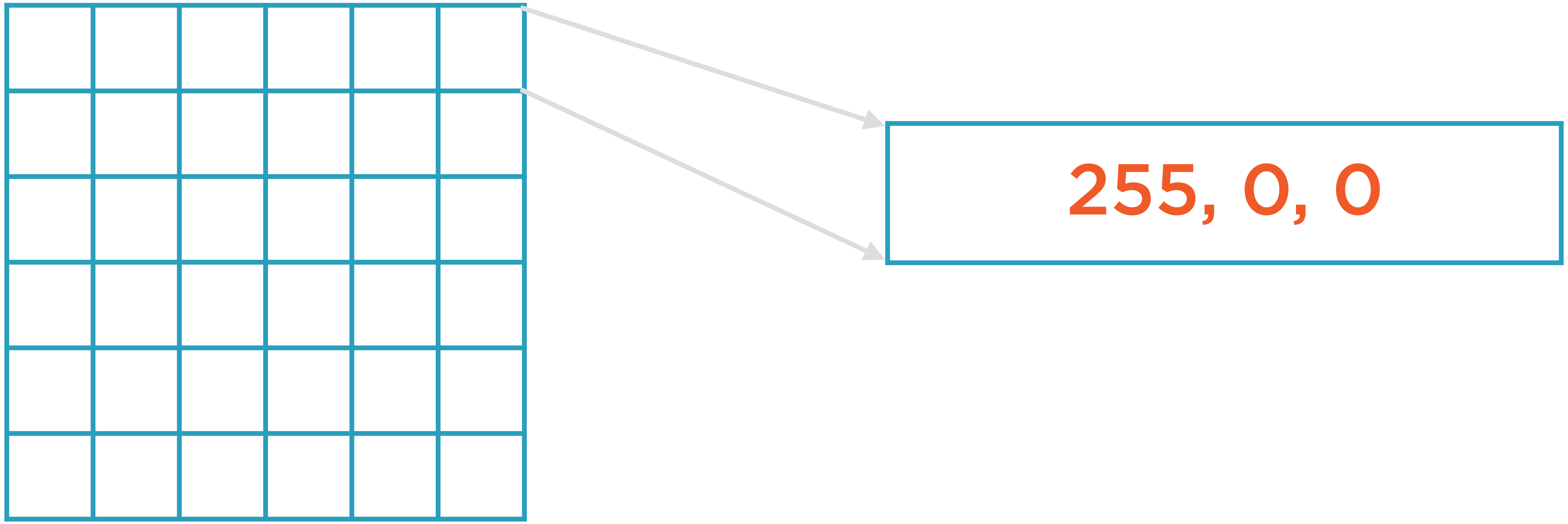
RGB Images



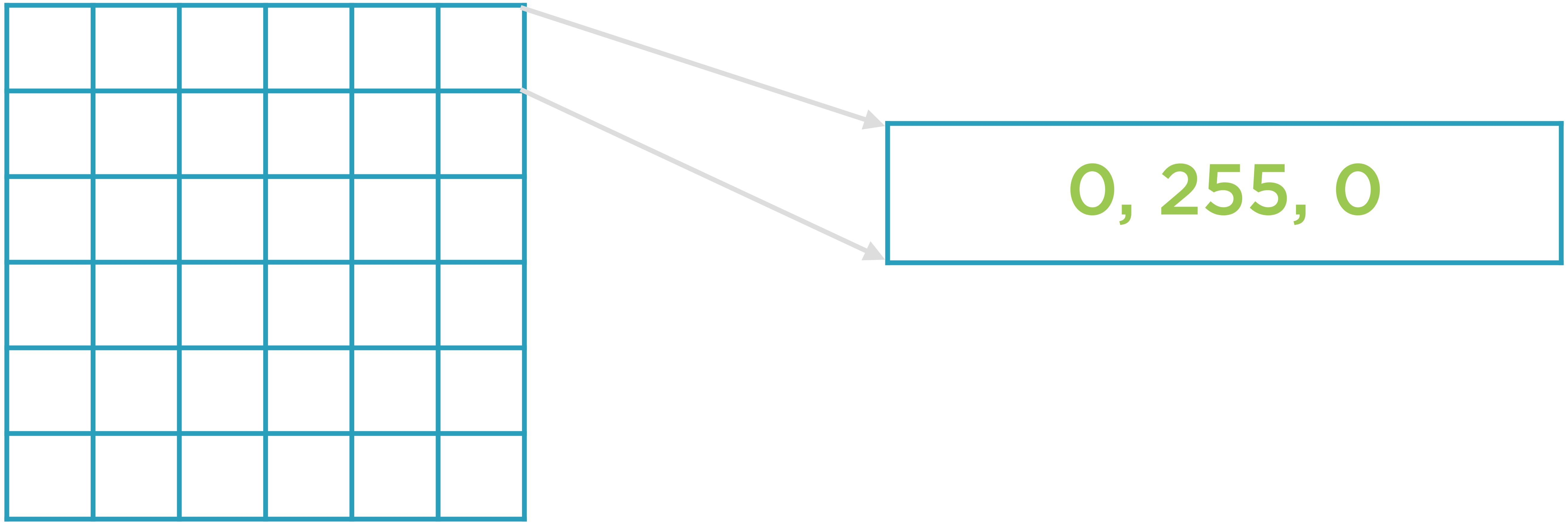
RGB values are for color images

R, G, B: 0-255

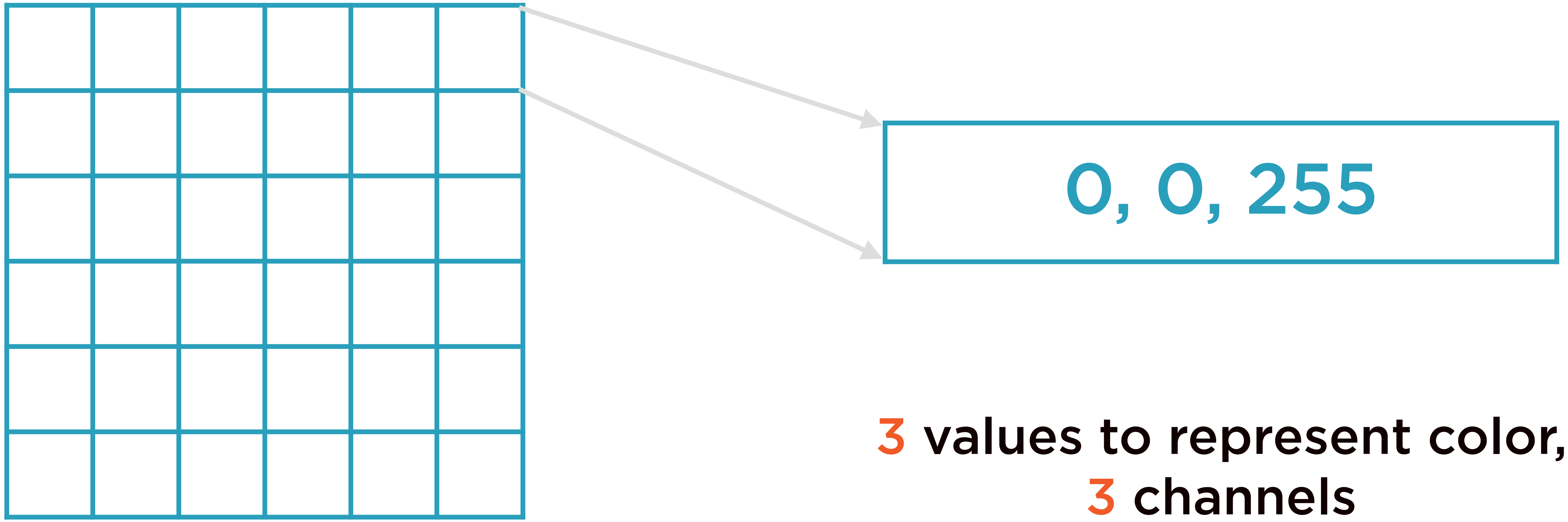
RGB Images



RGB Images

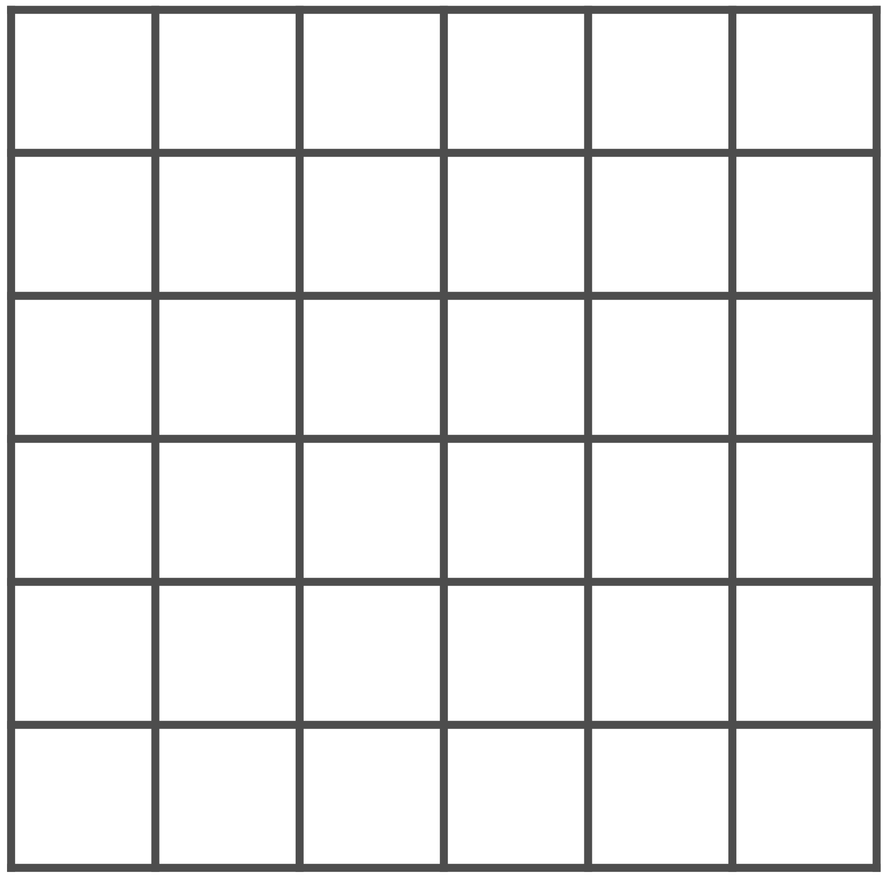


RGB Images

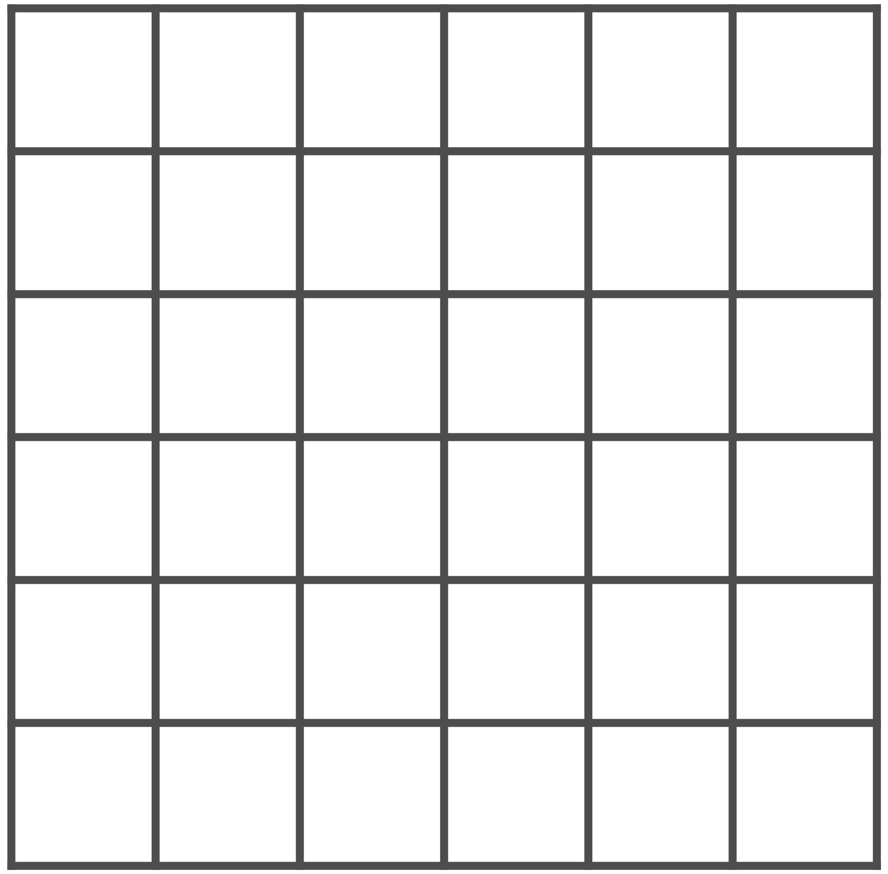


3 values to represent color,
3 channels

Grayscale Images



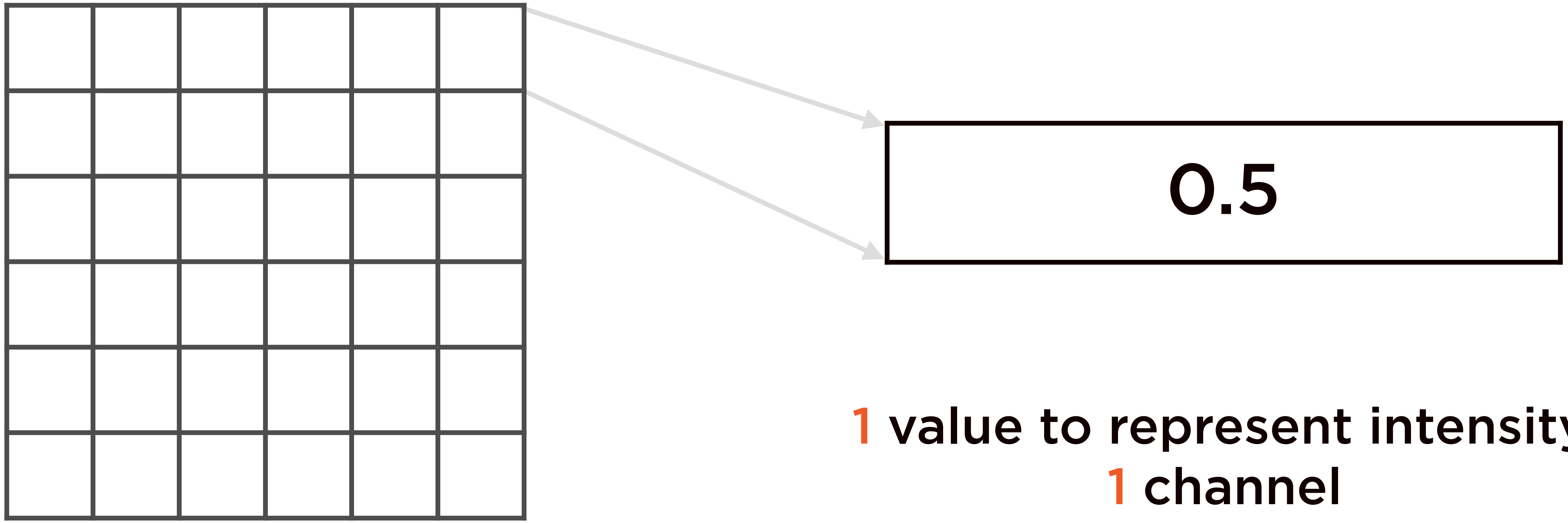
Grayscale Images



Each pixel represents only intensity information

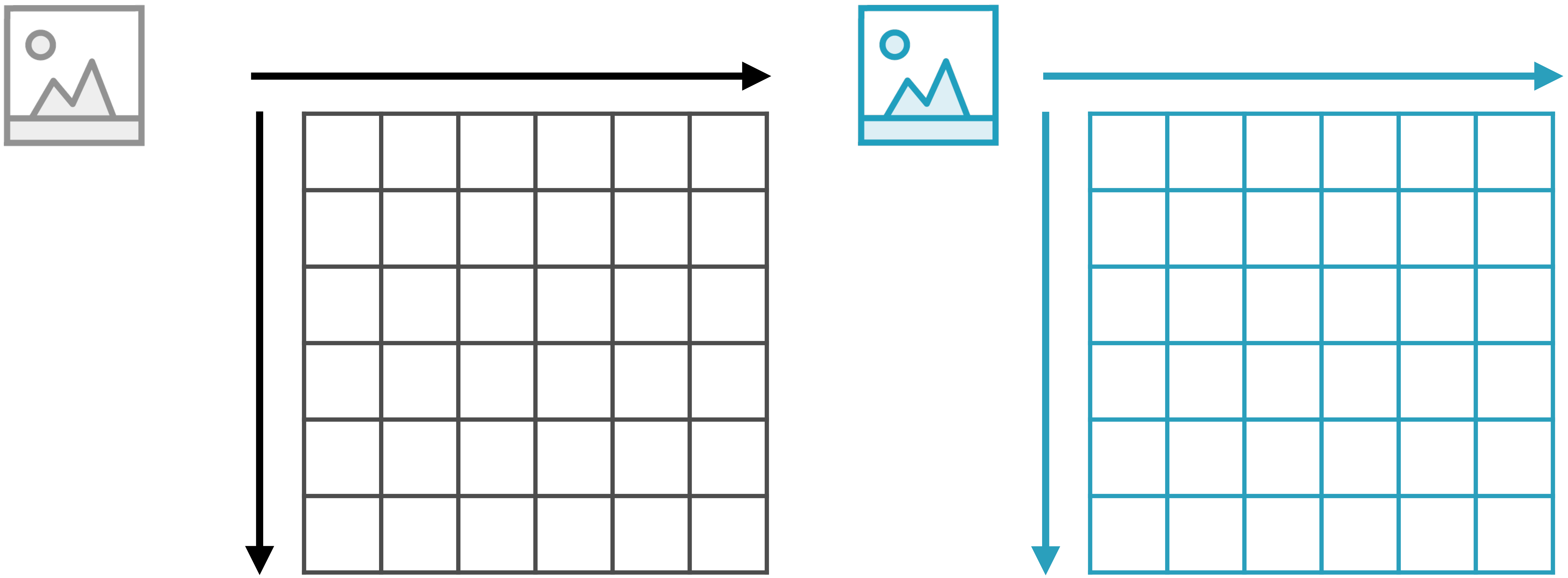
0.0 - 1.0

Grayscale Images



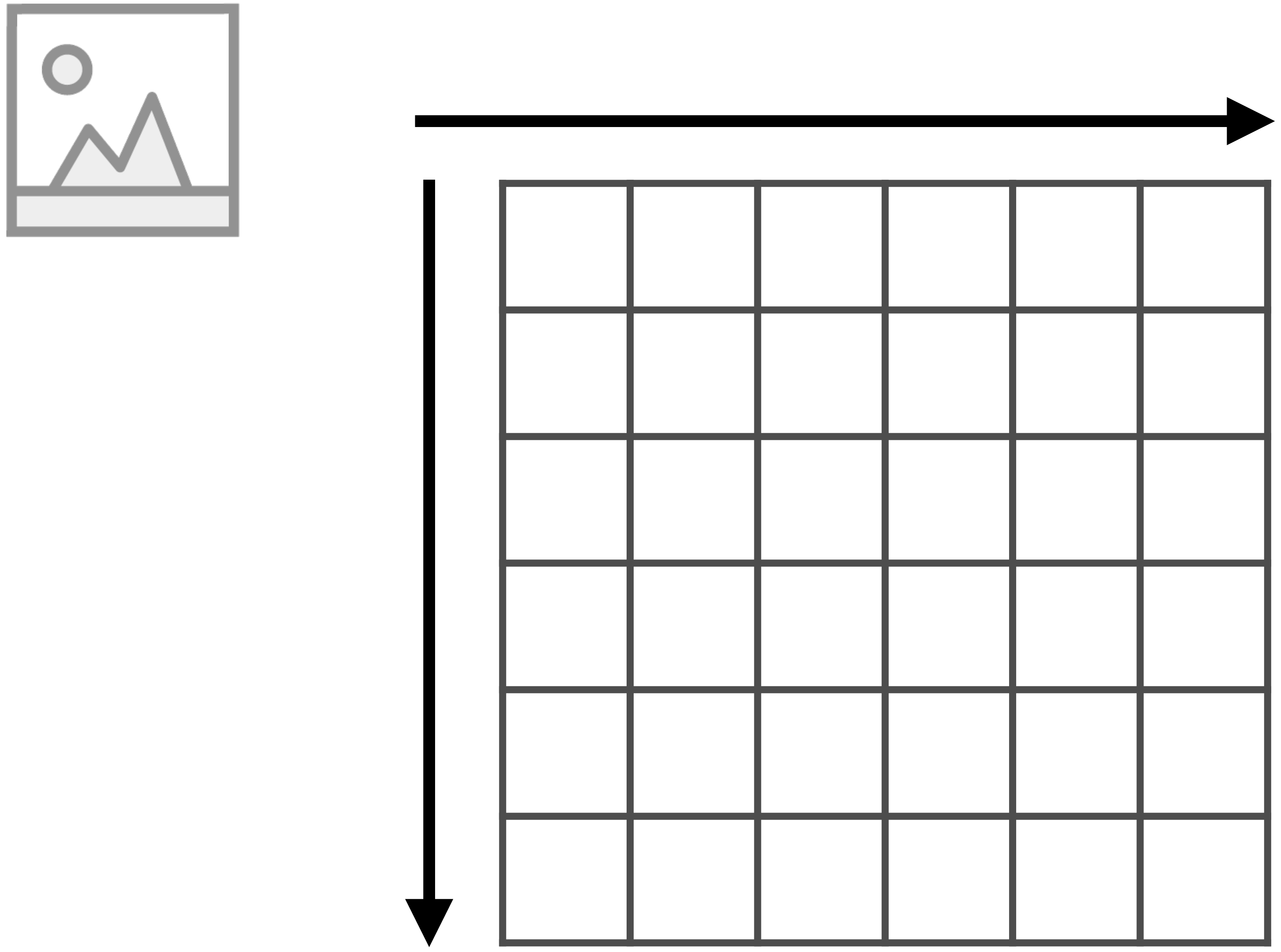
1 value to represent intensity,
1 channel

Images as Matrices

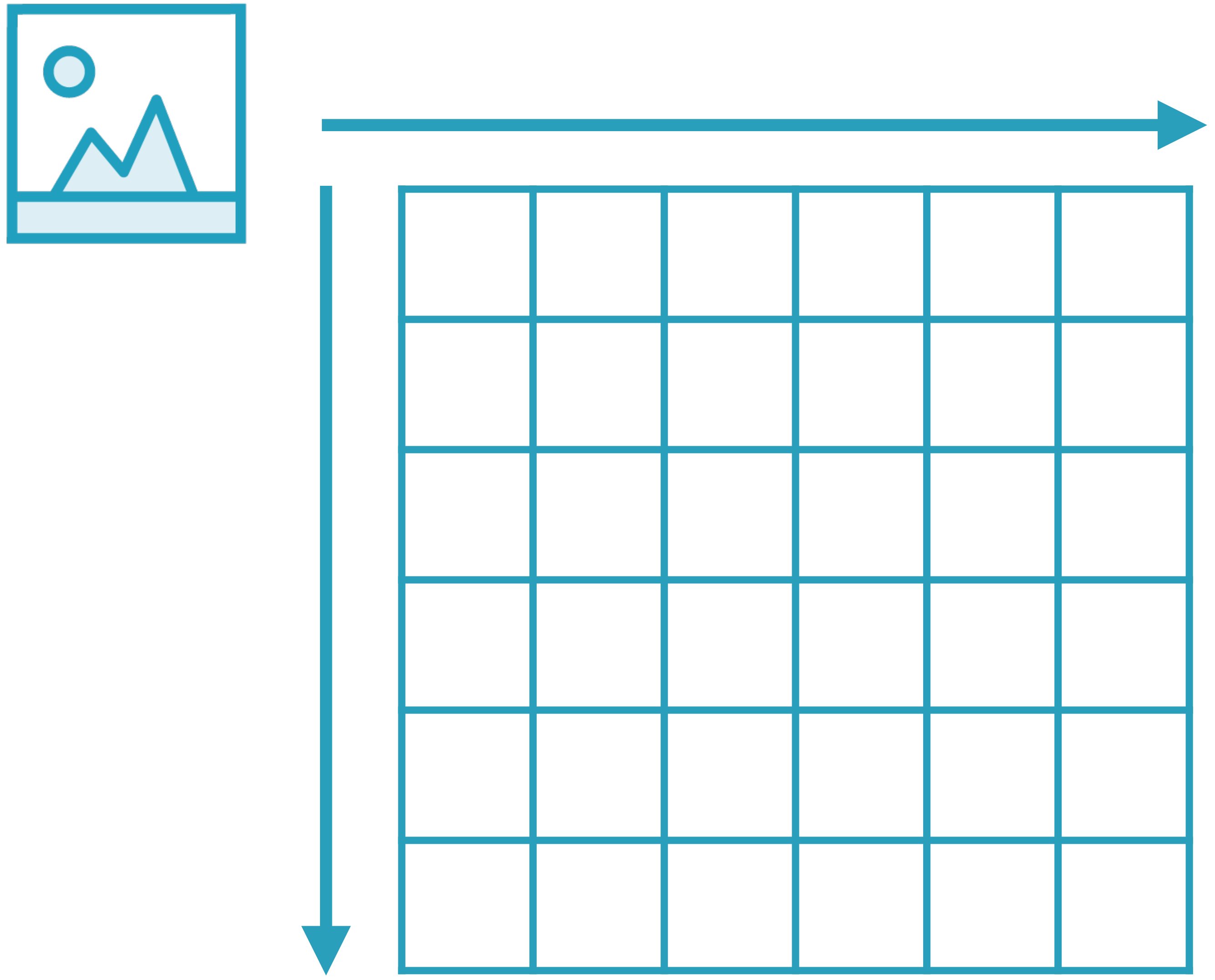


Images can be represented by a 3-D matrix

Images as Matrices



$(6, 6, \boxed{1})$



$(6, 6, \boxed{3})$

List of Images

(10, 6, 6, $\boxed{3}$)

The number of channels

List of Images

(10, $\boxed{6, 6}$, 3)

The height and width of each image in the list

List of Images

$$(\boxed{10}, 6, 6, 3)$$

The number of images

Feature Extraction from Images

Dictionary Learning

Representation learning method to find a sparse representation of input data, often used in denoising of images.

Noise

Random variations in images due to lighting variations, camera electronics, surface reflectance and lens.

Denoising

Process of removing noise from images, usually through the use of filters. Sparse codings from dictionary learning can also be used for denoising.

Dictionary Learning for Image Denoising

Corpus of clean images

Should be free of noise

Feed into Dictionary Learner

Perform Dictionary Learning

Express clean images in terms of atoms (sparse codings)

Each image is expressed as linear combination of atoms

Choose transformation algorithm

Implement numeric procedures

Several choices - Orthogonal Matching Pursuit (OMP), LARS

Use of Image Denoising

Apply to new, noisy images

Reconstruct and express using atoms

Dictionary Learning

Several choices of solver

- Thresholding: Fast but inaccurate
- Orthogonal Matching Pursuit (OMP): Most accurate, unbiased
- Least-angle Regression
- Lasso Regression

Image Descriptor

Descriptions of the key features of images.

Image Descriptors

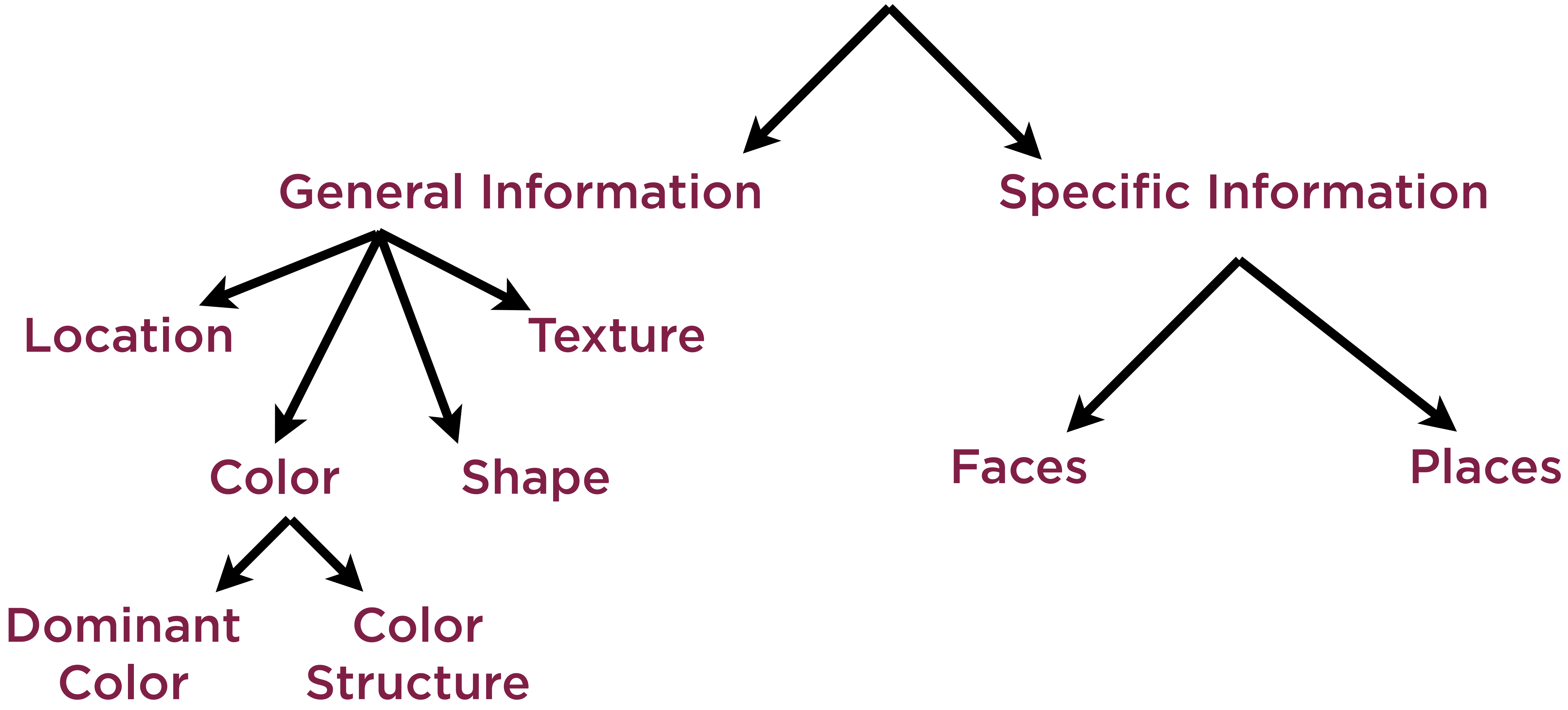
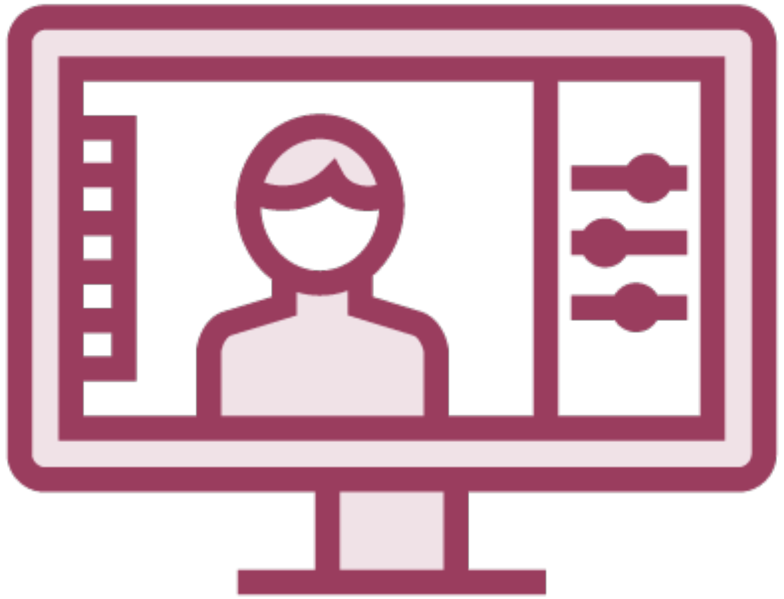


Image Descriptors



*S*cale *I*nvariant *F*eature *T*ransform (SIFT)

DAISY descriptors

Scale *I*nvariant *F*eature *T*ransform (SIFT)

Feature detection algorithm used to detect and describe features in images in a manner robust to translation, scaling and rotation

DAISY Descriptor

Feature selection algorithm, conceptually similar to SIFT, but faster and works with lower dimensionality feature vectors.

Simple Feature Extraction

Patch extraction

Connectivity graph

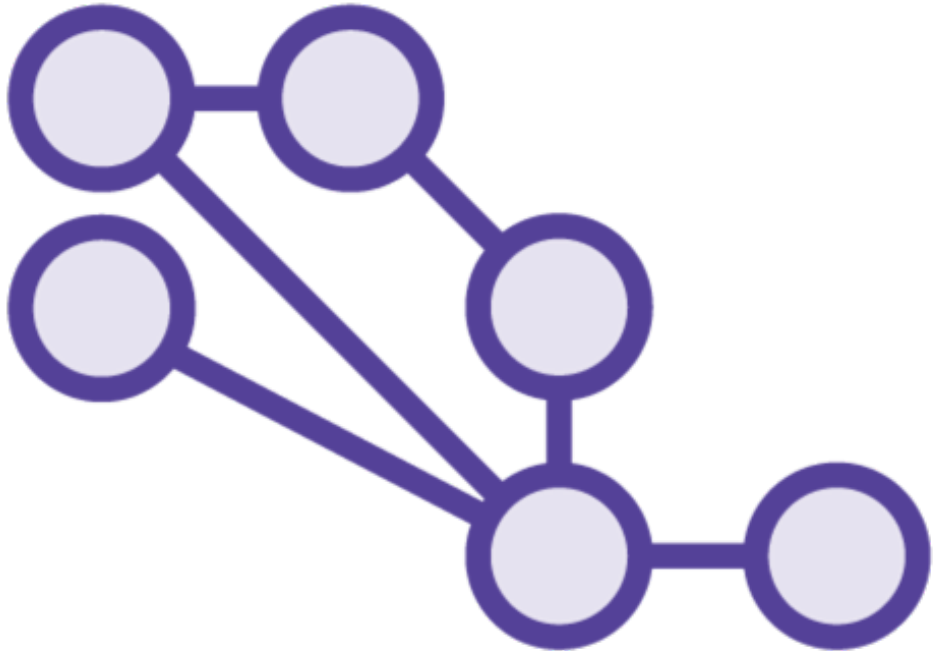
Patch Extraction

Extract patches from image

Could be 2D or 3D (color on 3rd axis)

Can rebuild image from patches

Connectivity Graph

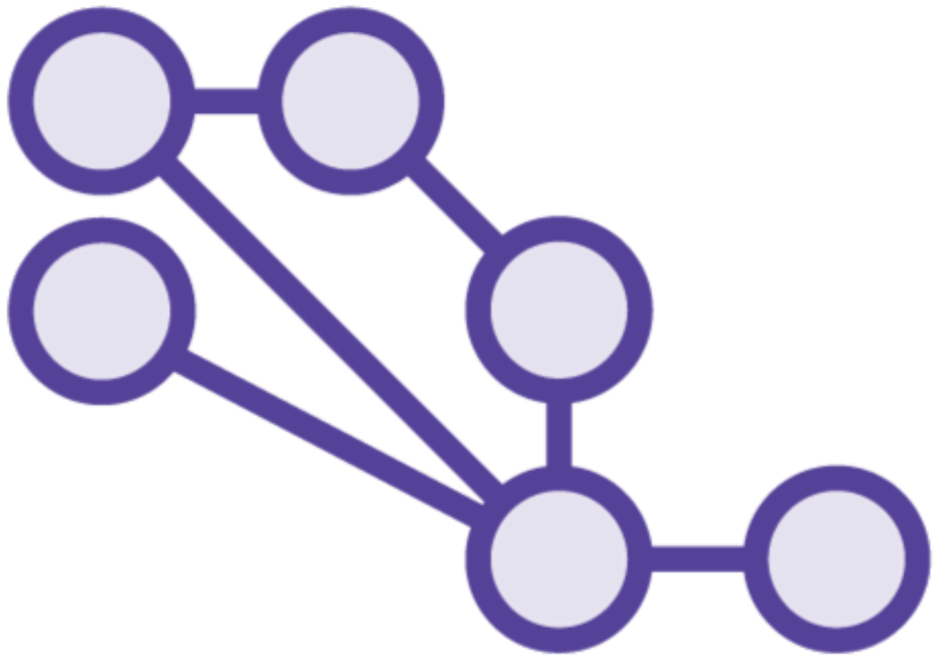


Extract connectivity information

Widely used as building block in more advanced techniques discussed above

Helps identify contiguous patches in images for clustering operations

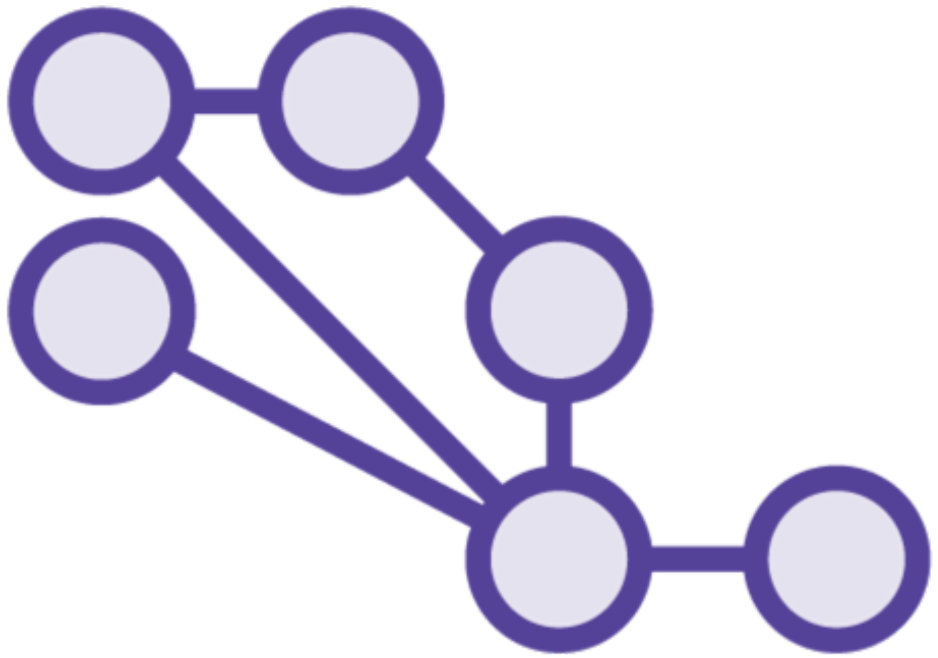
Connectivity Graph



`grid_to_graph` **returns matrix given shape of image**

- identifies pixel-to-pixel connectivity of images

Connectivity Graph



`img_to_graph` **returns matrix from 2D or 3D image**

- identifies pixel-to-pixel gradient connections
- directional change in the intensity or color of an image
- edges are weighed with gradient values

Demo

Denoising images using dictionary learning

Demo

Image feature extraction using a pixel-to-pixel connectivity graph

Demo

Image feature extraction using a pixel-to-pixel gradient connectivity graph

Summary

Representing images as feature vectors

Single channel and multi-channel image data

Extracting patches from images

Learning sparse codings using dictionary learning

Reconstructing images from patches

Representing images using connectivity graphs