COMP3420 — AI for Text and Vision

Week 03 Lecture 1: Convolutional Networks for Image Classification

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Programme

Reading

- Deep Learning book, Chapter 8.
- Computer Vision book, Chapter 3.

Programme

Remember: Supervised Machine Learning

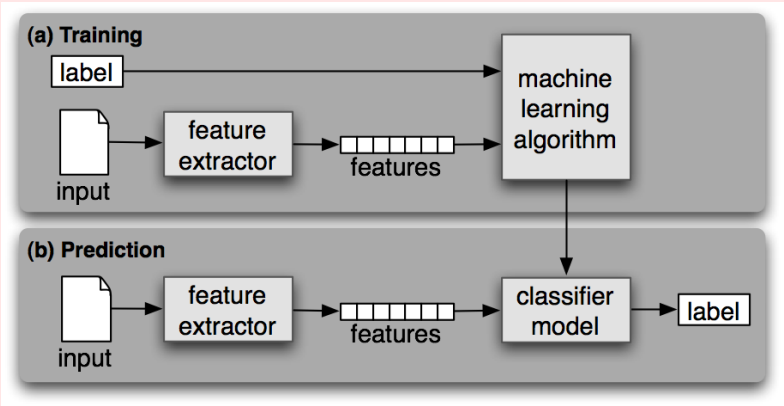
Given

Training data annotated with class information.

Goal

Build a model which will allow classification of new data.

Method



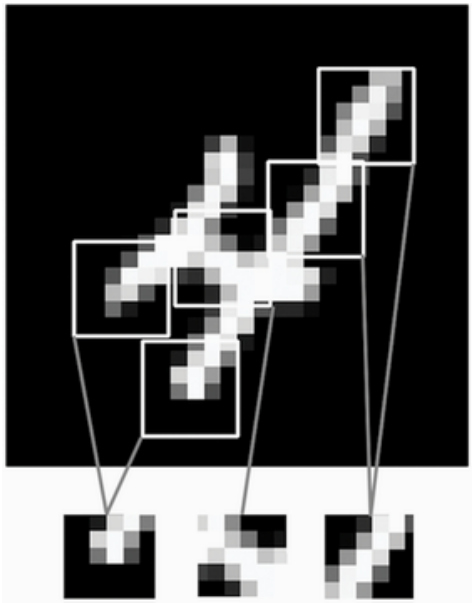
(figure from NLTK book)

- Feature extraction: Convert samples into vectors.
- Training: Automatically learn a model.
- Classification: Apply the model on new data.

Programme

Convolution layer vs a densely connected layer

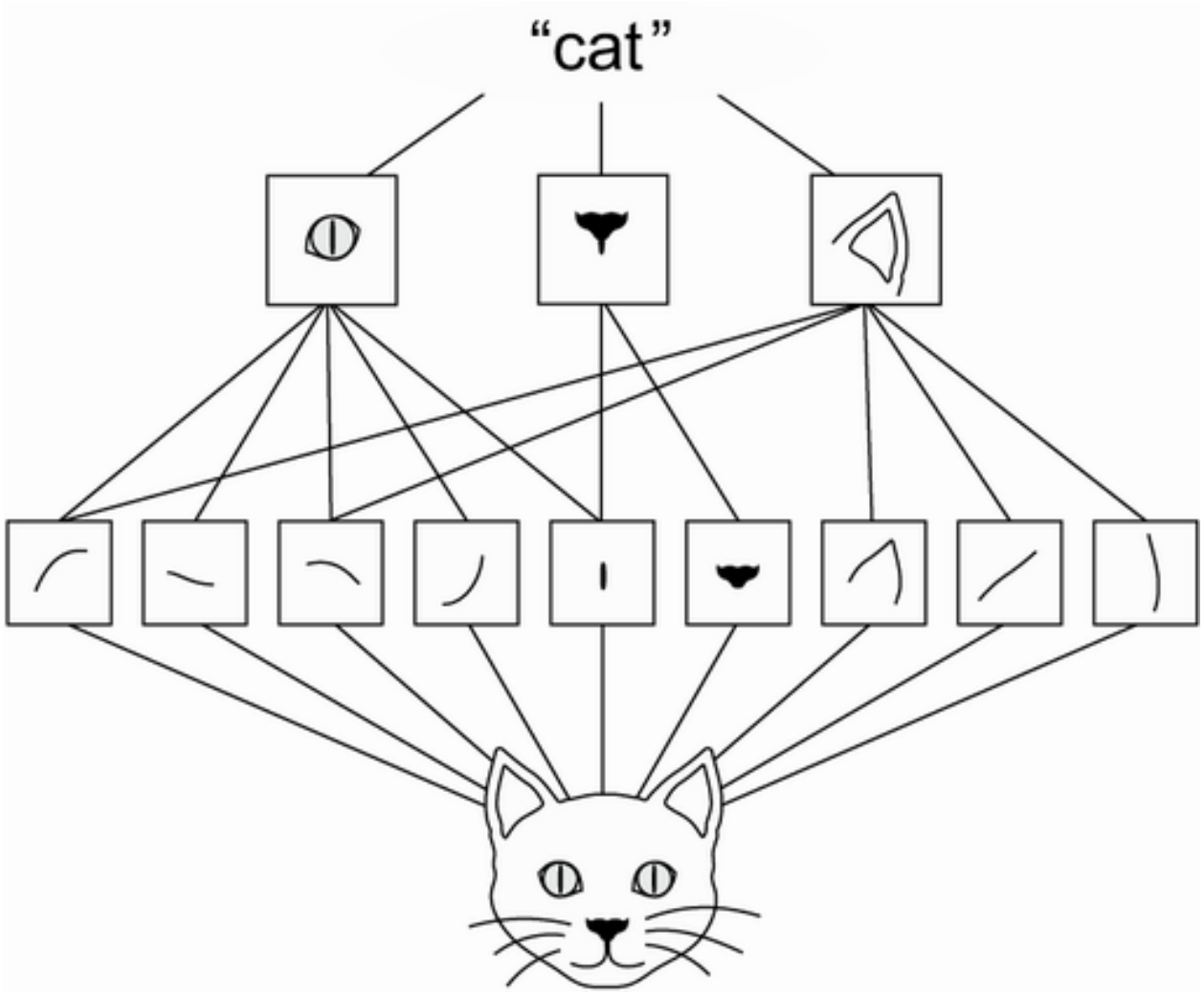
- A densely connected layer is able to detect information that is global to the entire image.
- Often, however, we want to detect information that is specific to parts of the image.
- Convolution layers focus on specific regions of the image and are able to detect local patterns.



Key Characteristics of ConvNets

- They can learn patterns based on specific regions of the image.
- The patterns they learn are invariant: After learning a certain pattern in one part of the image, a convnet can recognise it anywhere in the image.
- When we cascade convnet layers, they can learn spatial hierarchies of patterns.

Convolutional Networks can Extract Useful Features

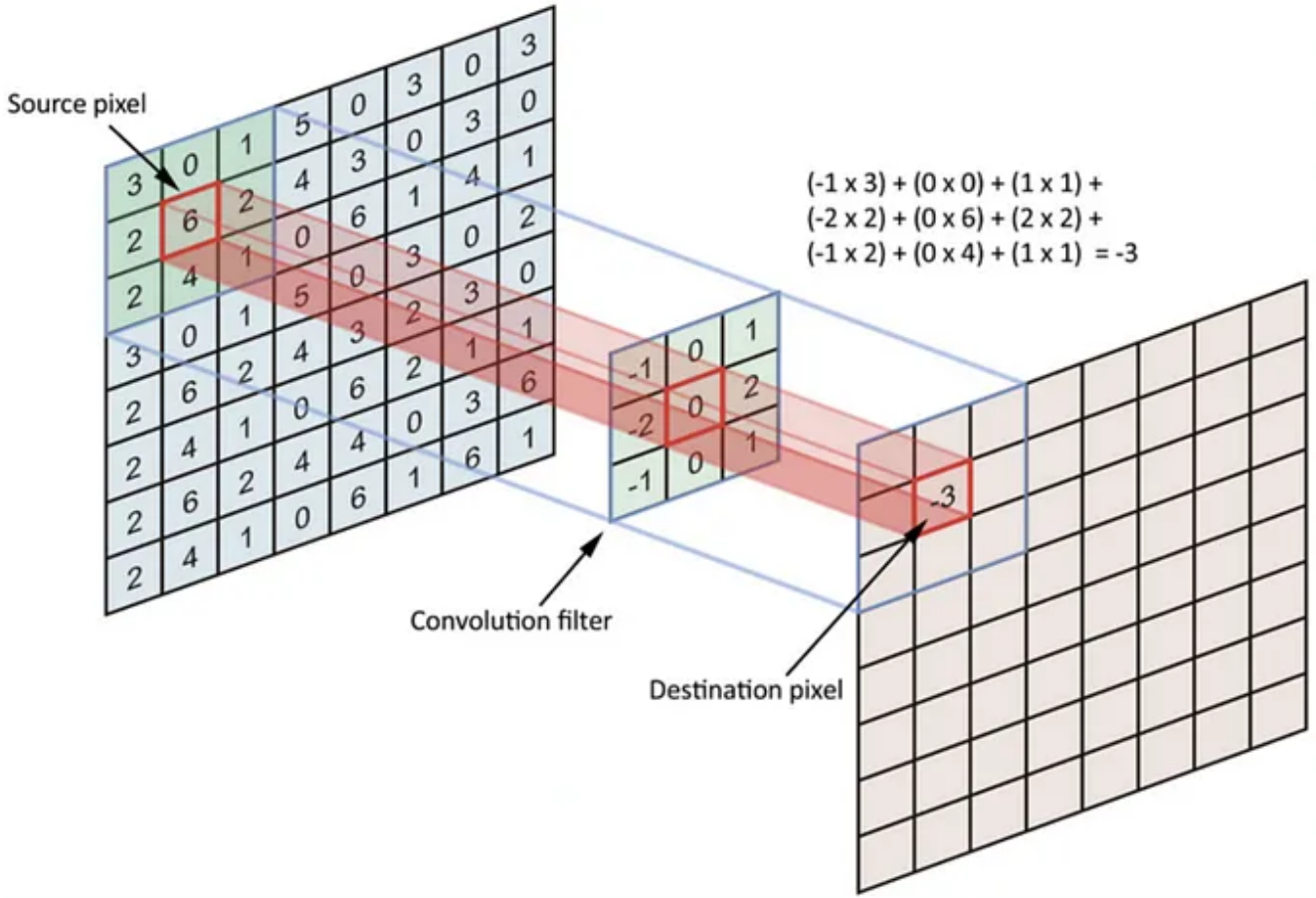


(Figure 8.2 from Deep Learning with Python)

A Convolution

- A convolution is a filter that applies to a specific part of the image.
- This filter is basically like a neuron in a densely connected layer that takes as input a part of the image only.
- The convolution filter is then slid across the image.

The Convolution Operation



(https://towardsdatascience.com/simple-introduction-to-convolutional-neural-networks-cdf8d3077bac)

Anatomy of a Convolution

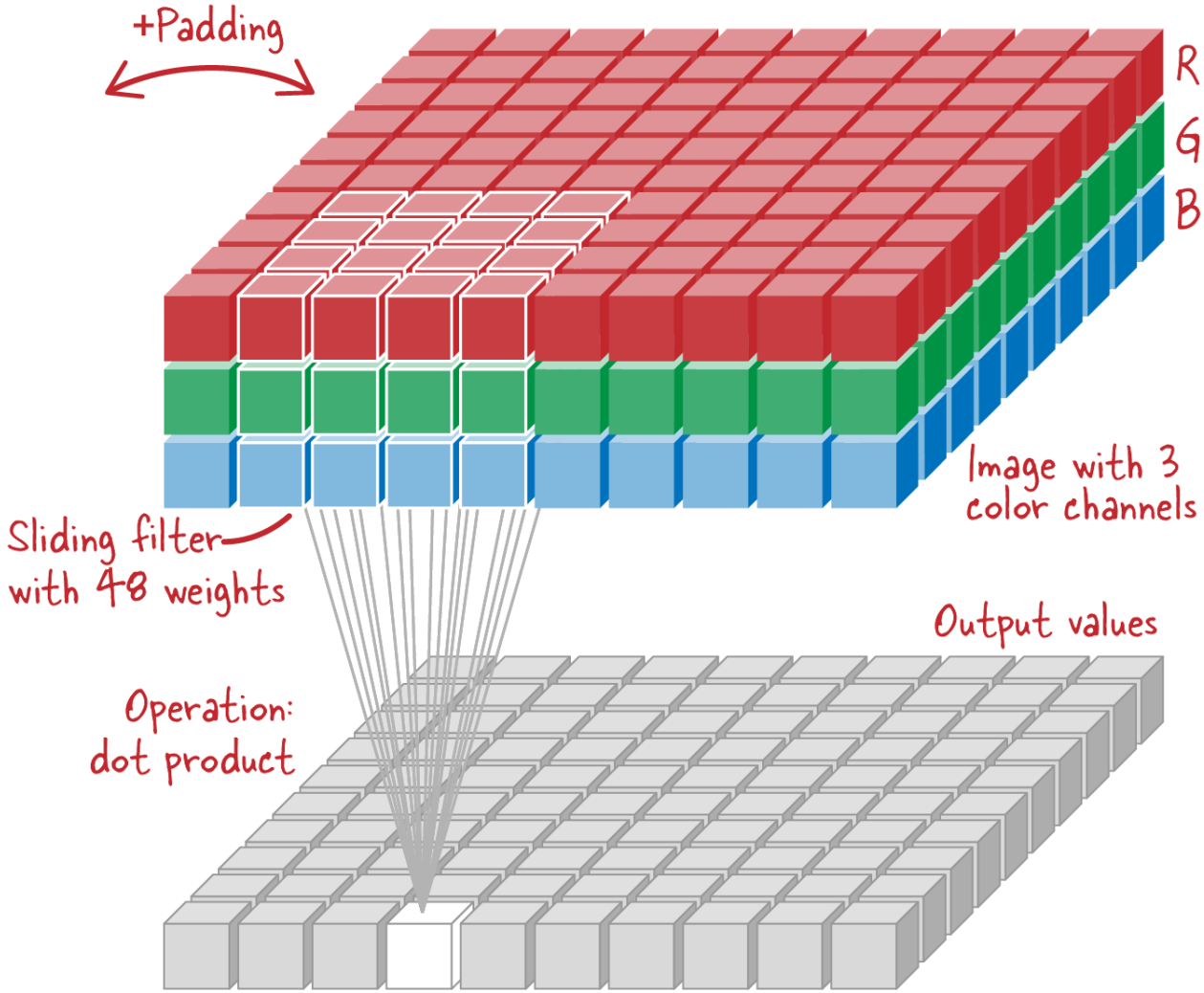
Padding. We often want to pad the original image, with a set value (e.g. 0), so that we can apply the convolution filter to the edges of the image. If there is no padding, the resulting image after the convolution is slightly smaller.

Kernel size. The shape of the filter. A filter with size x will process parts of the image with shape (x, x, c), where c is the number of channels.

Stride. The stride is the number of cells that we skip between each pass of the sliding filter.

Activation. Often, we want to add an activation function that will apply after the convolution operation.

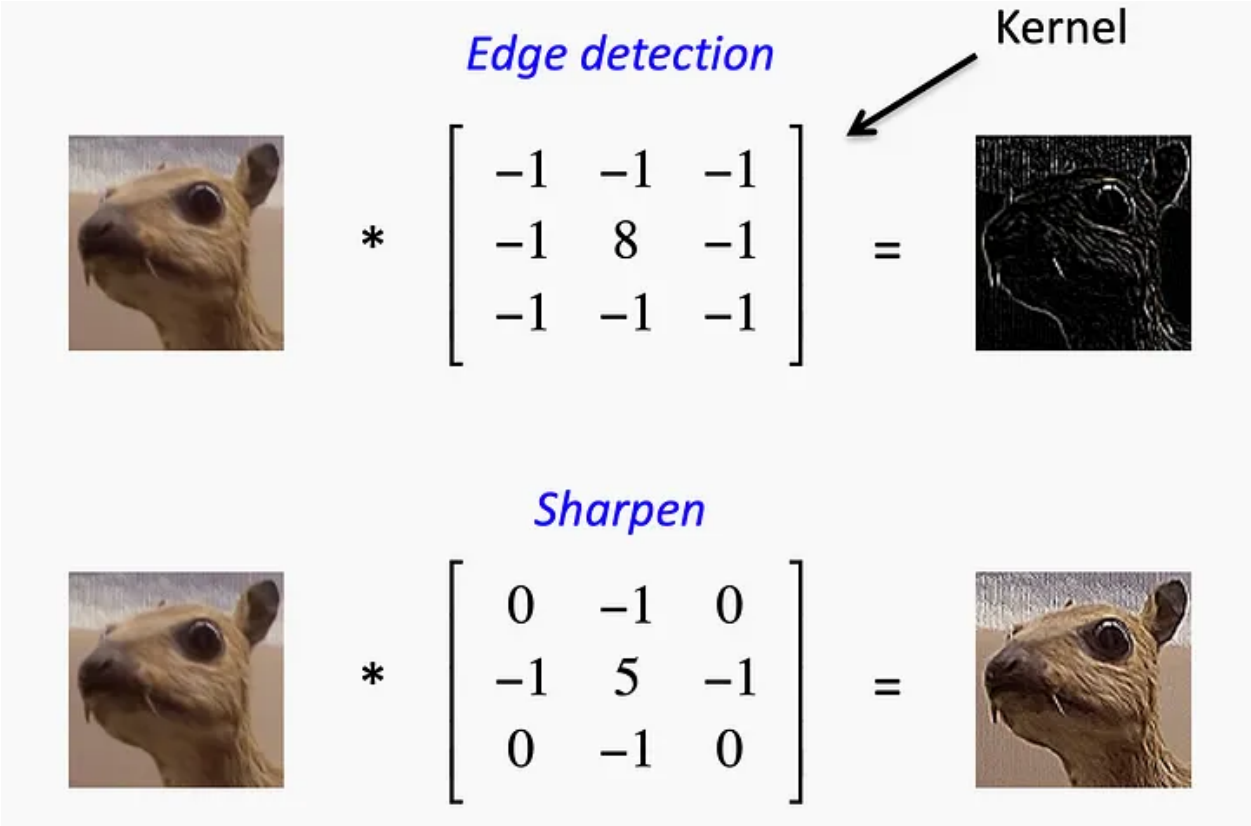
Anatomy of a Convolution



(Figure 3.9 of "Practical Machine Learning for Computer Vision")

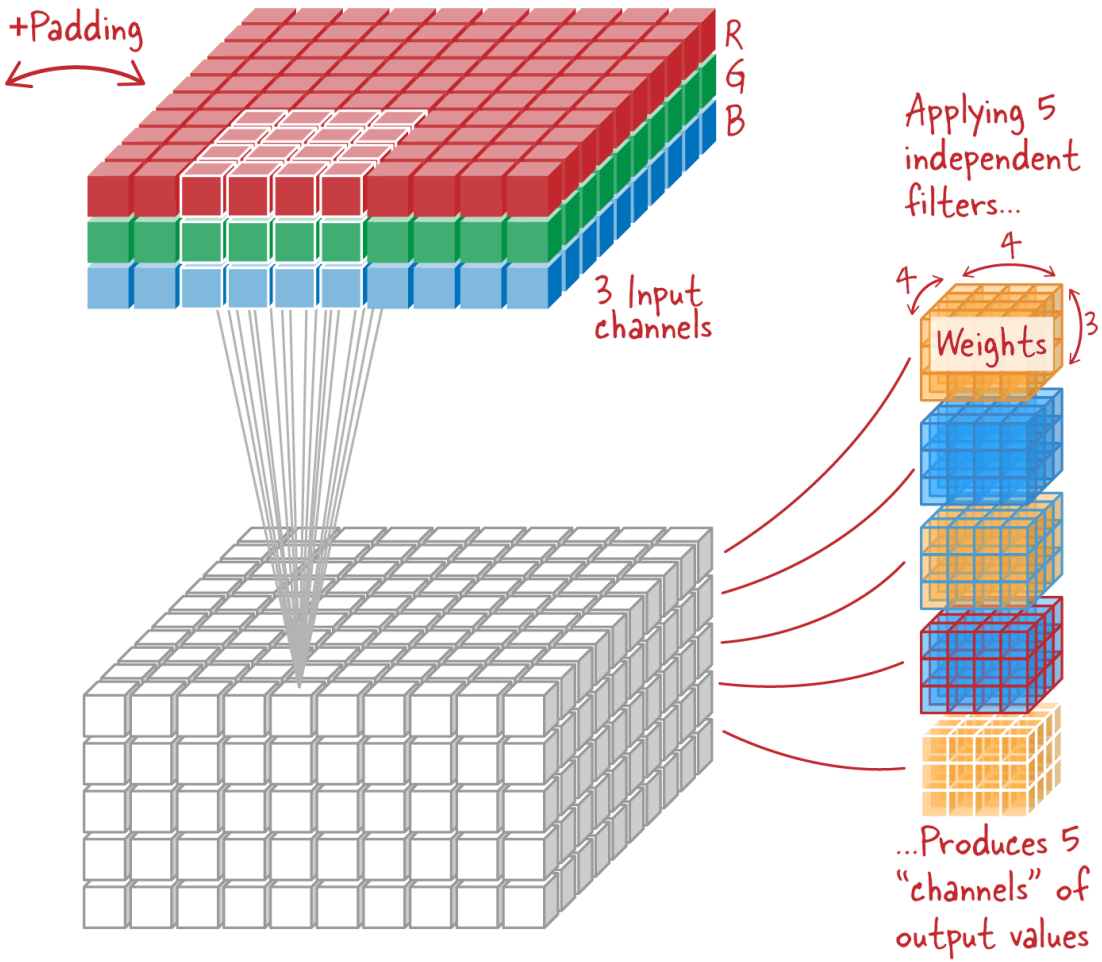
Examples of Filters

Below are examples of weights to make specific filters. In practice, the network will learn the best values during the training stage.



(https://towardsdatascience.com/simple-introduction-to-convolutional-neural-networks-cdf8d3077bac)

Using Multiple Filters



(Figure 3-11 from Computer Vision book)

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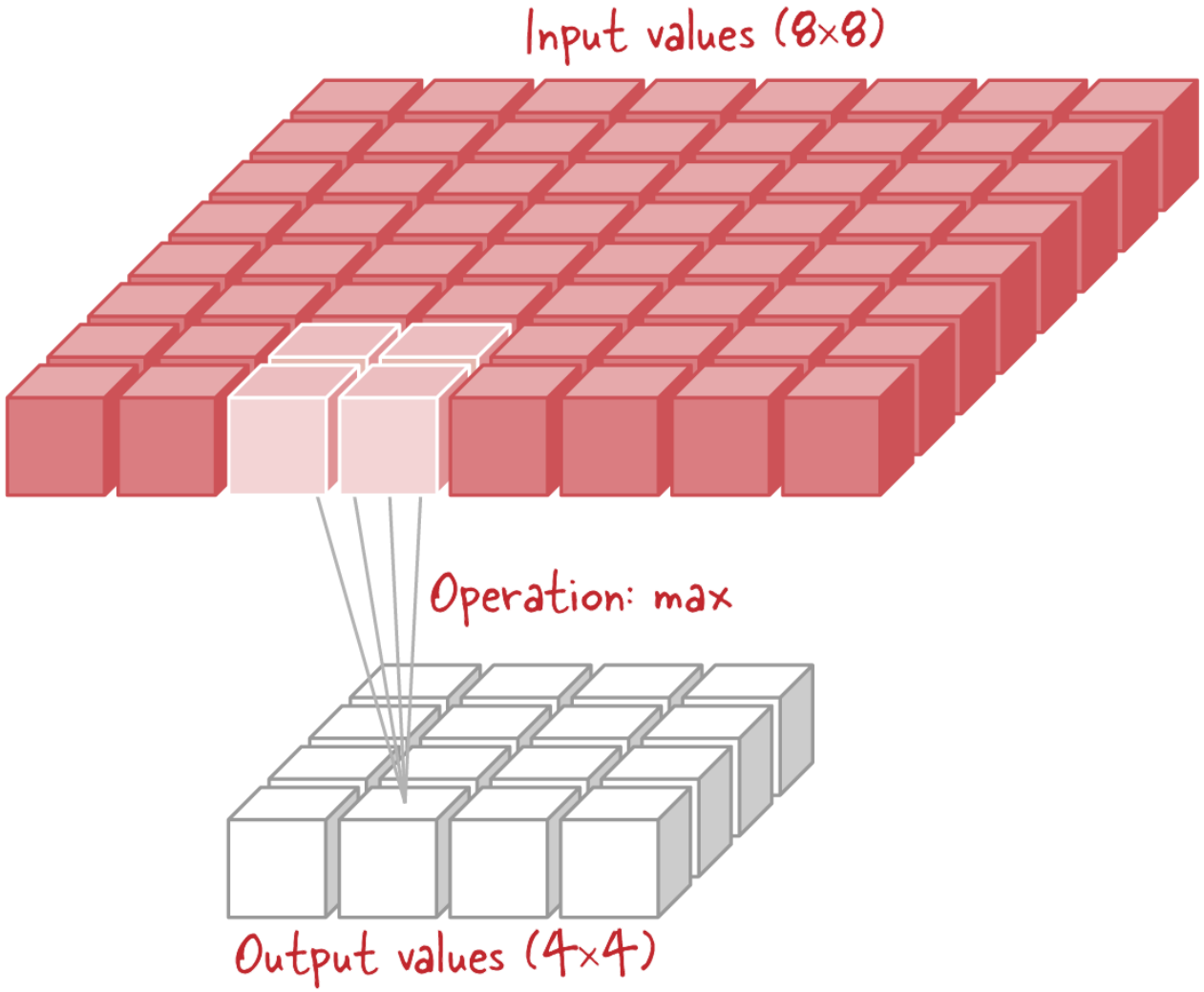
Pooling

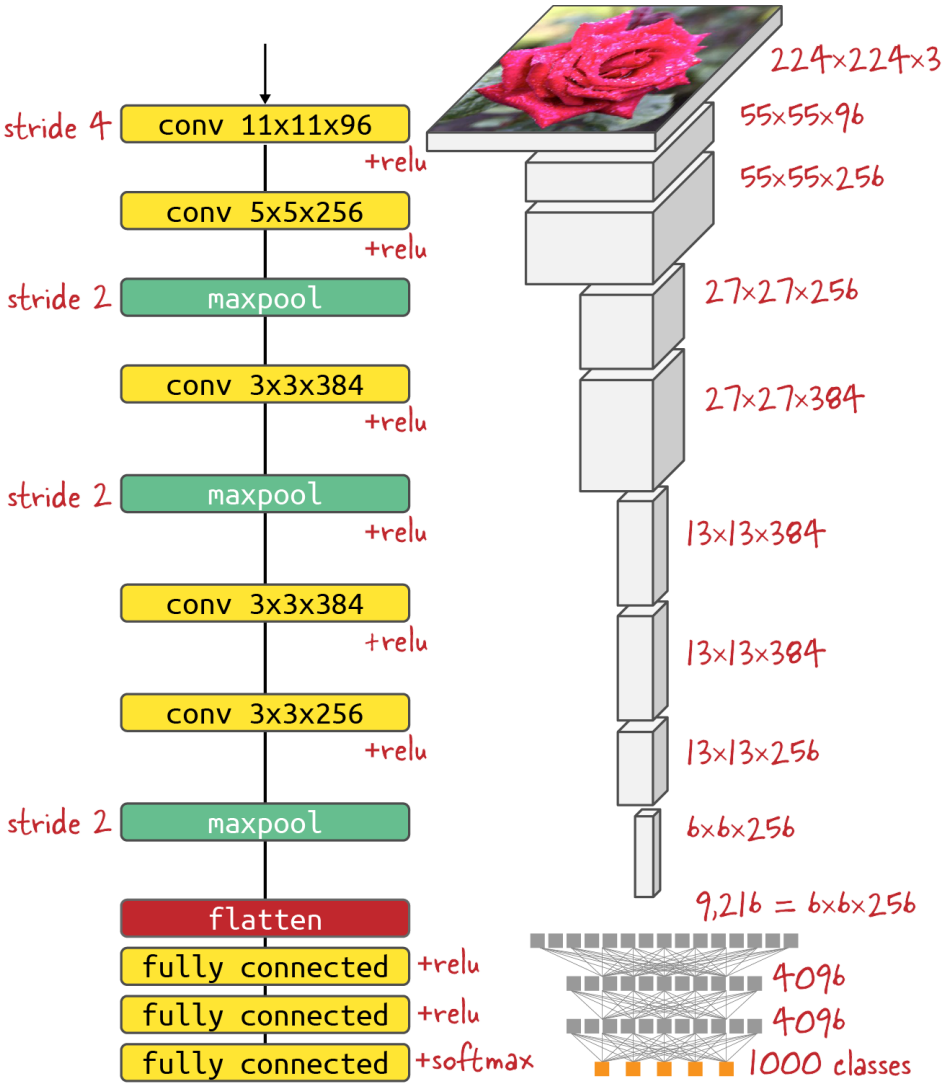
- A convolution layer is often followed by a pooling layer.
- A pooling layer will combine all values of a region of the resulting image into a single number.
- Often, we use Max Pooling, that is, choose the largest value from the region.

Example of Pooling



(Figure 3-14 from Computer Vision book)

Example of a Full Architecture: AlexNet



(Figure 3-16 from Computer Vision book) AlexNet (2012) was one of the early successes of ConvNets.

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Convolutional Networks in Keras

- This section is based on jupyter notebooks provided by the unit textbooks.
- Study these notebooks carefully.
- The notebooks also introduce important terminology that you need to understand.

Take-home Messages

1. Explain the advantages of convolutional layers vs. dense layers.
2. Explain convolutional and pooling layers.
3. Using Keras, implement image classifiers that include stacked convolutional and pooling layers.

What's Next

Assignment 1

- Submit Friday 10 March, 11:55pm

Week 4

- Advanced Convolutional Networks.
- Friday 17 March: Census Date.

Reading

- Computer Vision book, chapter 3.
- Deep Learning book, chapters 8 and 9.