San José State University

Math 251: Statistical and Machine Learning Classification

Introduction to Deep Learning (Resources)

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Fully connected layers are not ideal for images

There are at least three reasons:

- Fully connected layers use a lot of parameters which can cause overfitting
- Vectorizing an image destroys its 2-D structure
- Images, despite being very complex overall, tend to have localized contents (thus there is no need to input all pixels to each neuron on next layer)

Convolutional neural nets are experts on image data and can address all of the above issues.

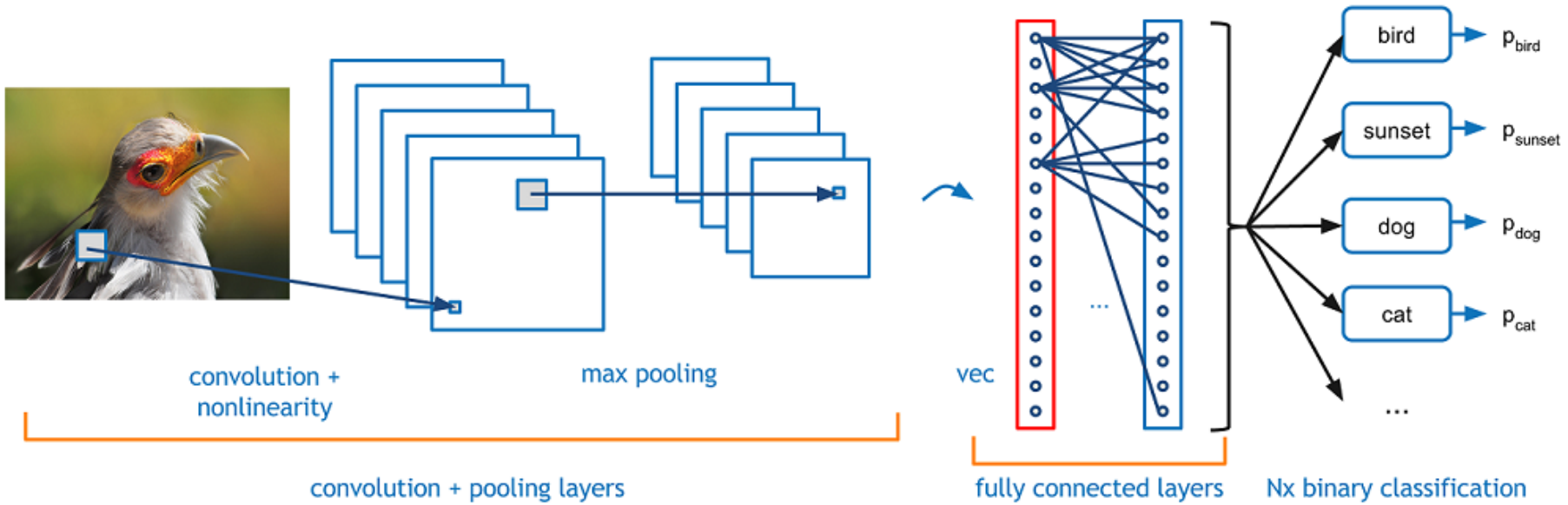
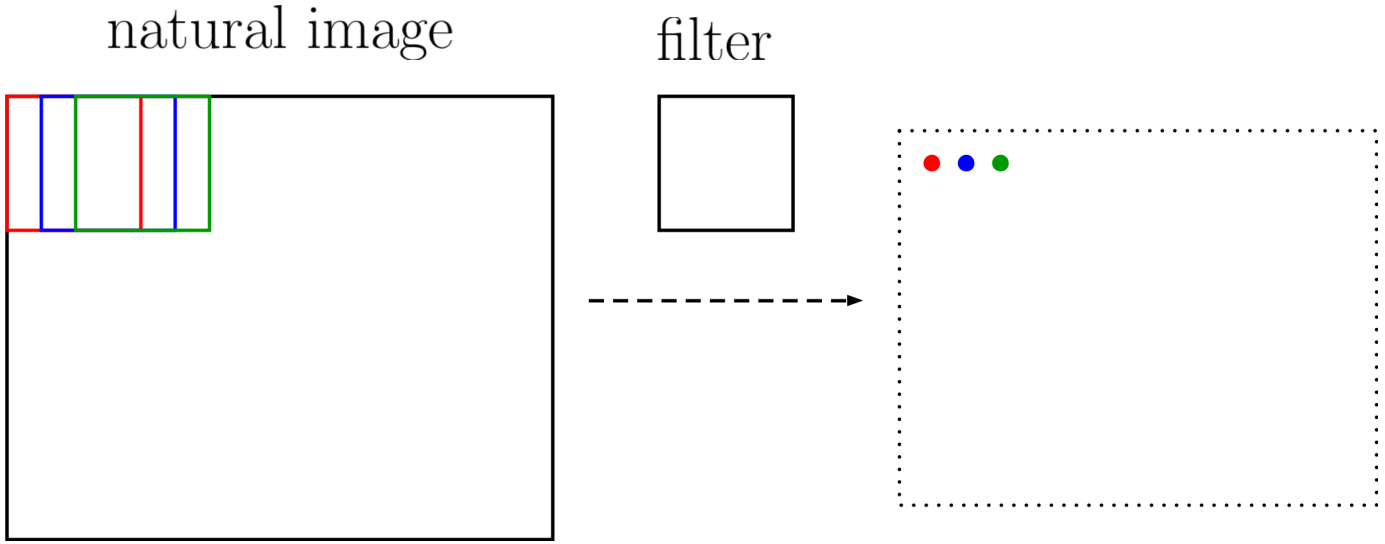


Image filtering

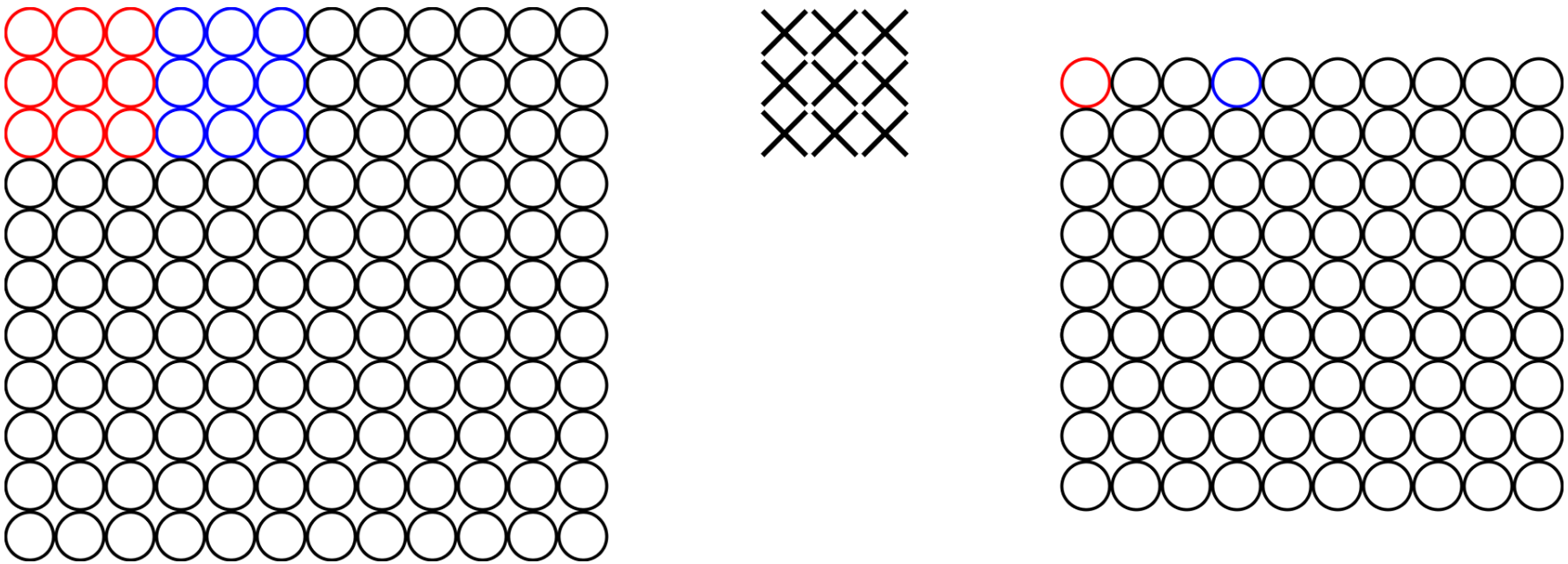
An image filter is a small matrix (of certain size $b \times b$) that is applied (through dot product) to every patch of the same size in another (bigger) image. The operation is called convolution and the outcome is still an image.



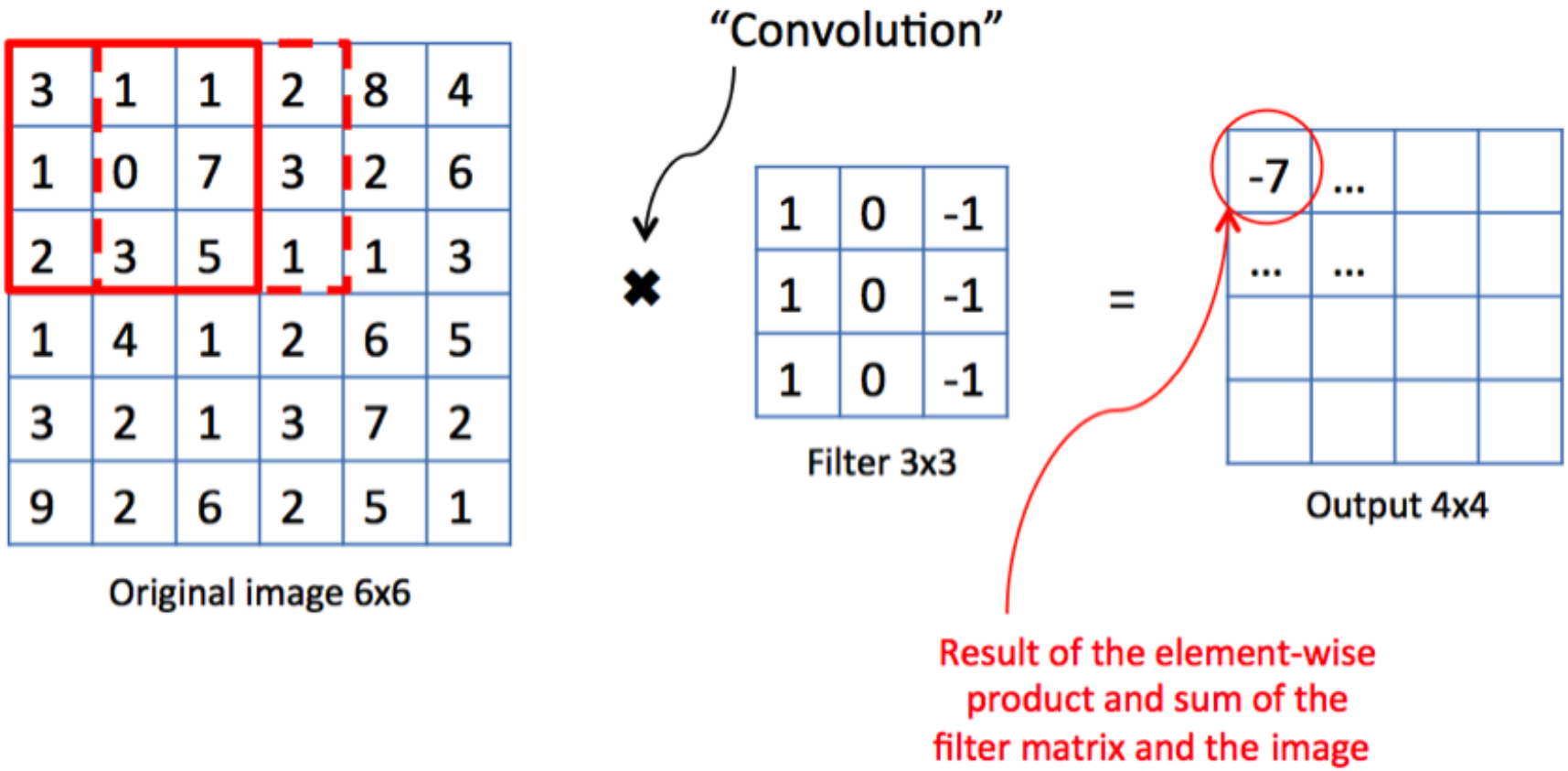
See `https://ai.stanford.edu/~syyeung/cvweb/tutorial1.html`

What is a CNN?

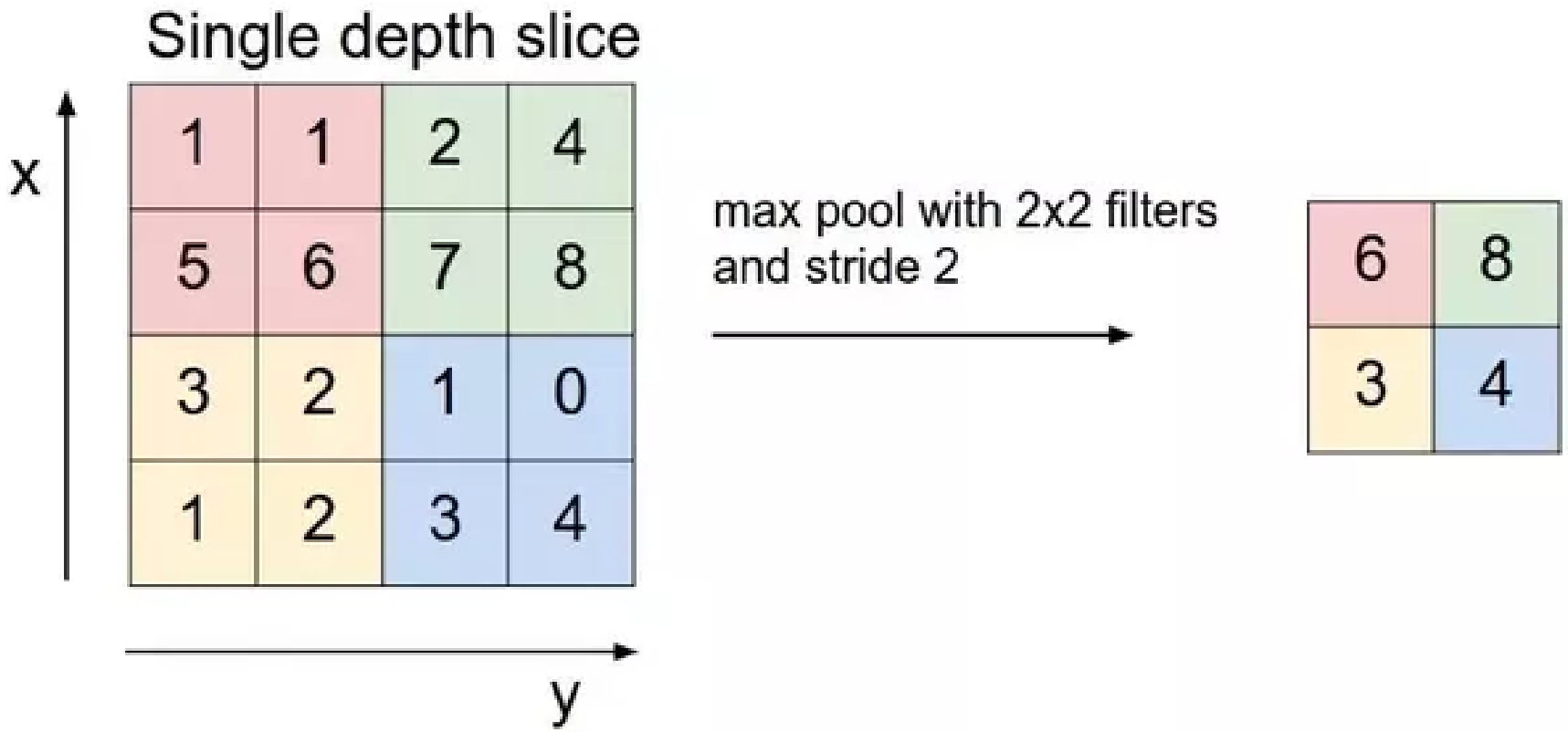
Neurons are arranged in 2D arrays and only nearby neurons (pixels) are connected to the same neuron in next layer, in a weights-sharing fashion.



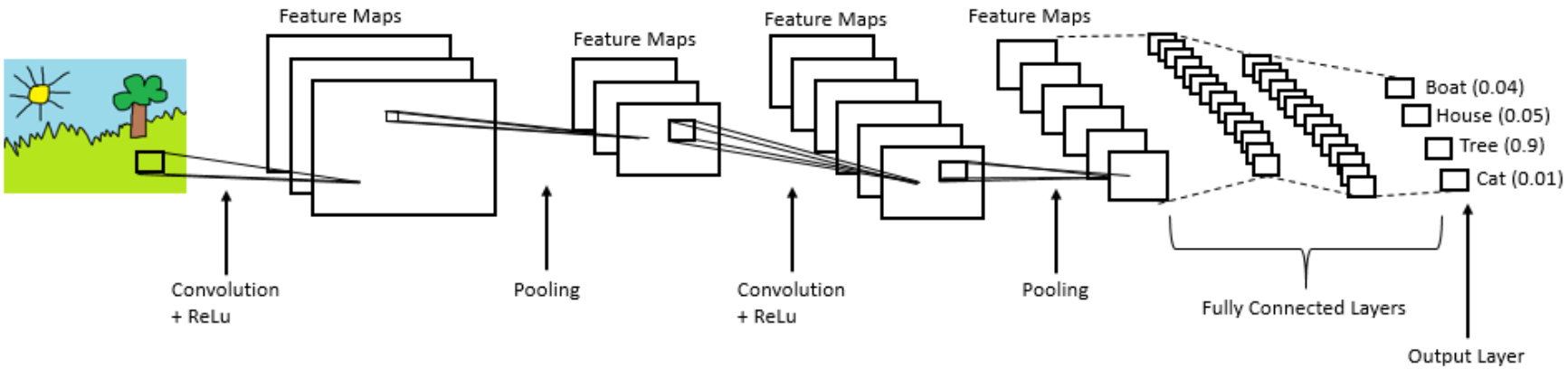
The convolutional layer



The pooling layer



The entire CNN architecture



MIT lecture on deep learning

To learn more on CNN, see lecture 3 (deep computer vision) on

`http://introtodeeplearning.com`

More learning resources on deep learning

- Chapter 6 of Nielson's book (which also gives a nice introduction to CNN)
- Stanford CS 231n[1]: Lectures 5 (CNN) and 6 (transfer learning)
- SJSU CMPE 258 Deep Learning (offered every spring):
  Deep neural networks and their applications to various problems, e.g., speech recognition, image segmentation, and natural language processing. Covers underlying theory, the range of applications to which it has been applied, and learning from very large data sets. Prerequisite: CMPE 255 Data Mining or CMPE 257 Machine Learning or instructor consent

[1] `http://cs231n.stanford.edu/schedule.html`