INFO251 – Applied Machine Learning

Lab 10

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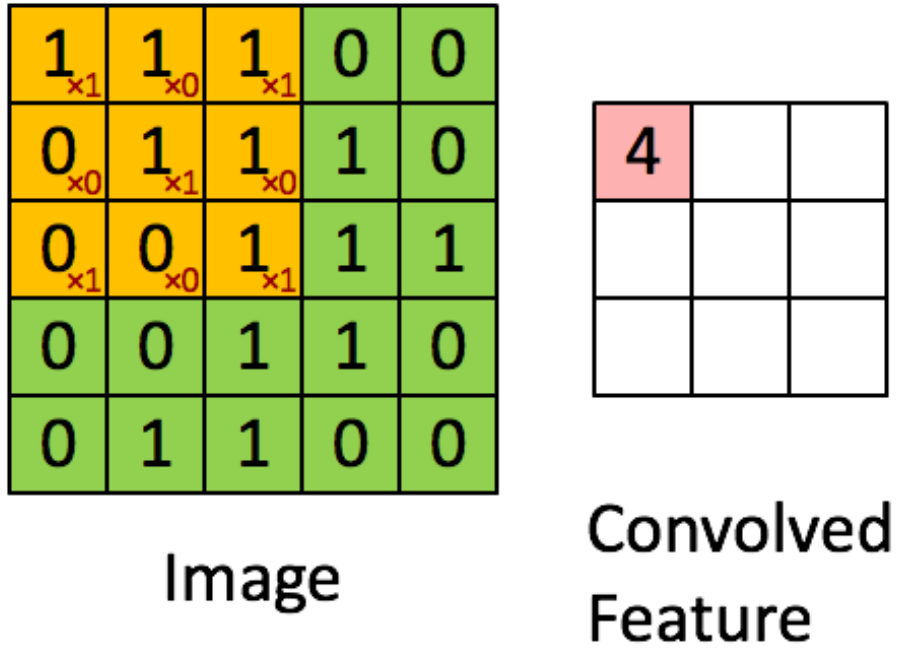
Topics

- Convolutional neural networks (CNNs)

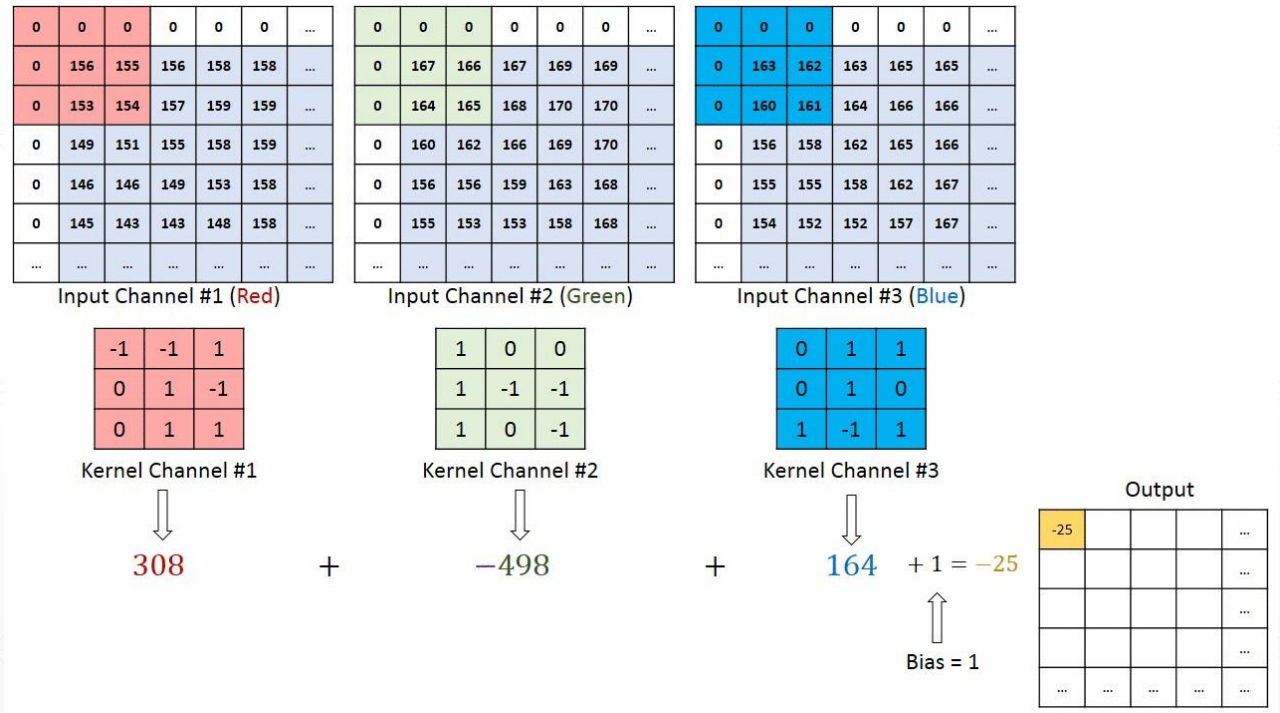
Convolutional Layers

- Goal: Capture the spatial dependencies in parts of an image
- Multiply a **kernel matrix** ("**filter**") *k* by subsets of the input image
  - Hyperparameter: Size of *k* (often 3x3, 5x5, or 7x7)
  - Learn: The weights of *k*
- **Stride**: How to shift the kernel matrix
  - Hyperparameter: Stride value (integer)



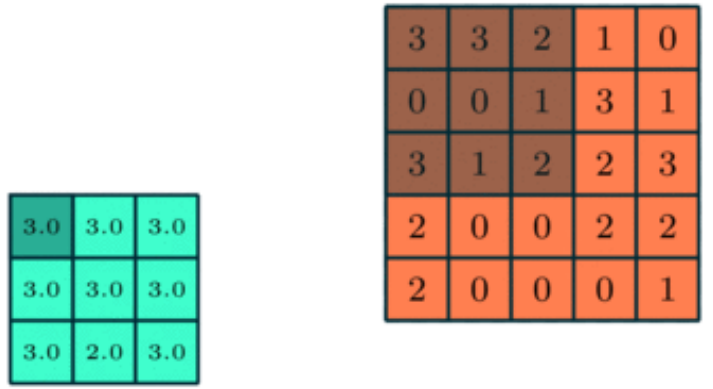
Convolutional Layers

- **Channels:** Number of ”layers” in the input image
  - Grayscale: 1 channel
  - RGB: 3 channels
  - RGBA: 4 channels
- Same filter size and stride length, but each channel has different weights
- Outputs of channels are summed up



Pooling Layers

- Goal: Reduce size of convolved layer to decrease compute cost
- Again, operates kernel matrix *k* over the convolved matrix
  - Hyperparameter: Size of *k* (usually 2x2)
  - Hyperparameter: Stride width (usually 2)
- **Max pooling**: Return maximum value in area covered by kernel
- **Average pooling**: Return average value in area covered by kernel



Convolutional Neural Network Structure

- Convolutional layer
- Pooling layer
- Convolutional layer
- Pooling layer

Repeat convolution followed by pooling any number of times. Option to add dropout after pooling.

- Flatten
- Fully connected layer(s) (activation: sigmoid/tanh/relu)

Add any number of fully connected layers. Option to add dropout.

- Output layer (activation: determined by problem type)

Dimensions

- In general, output size from a convolutional layer: $[(N - F + 2P)/S] + 1$
  - N: Input image dimensions (e.g. **28** X 28)
  - F: Filter / Kernel dimension(e.g. **3** X 3)
  - P: Padding (default 0)
  - S: Stride (default 1)
- Number of parameters associated with a convolutional layer: $((f * f * d)+1)* k)$
  - d is the number of filters/ channels in the previous layer
  - k is the number of filters in the current layer

Example: VGG-16 (Simonyan & Zisserman, 2015)