

3. Convolutional Neural Network

A Quick Note on Loss

Mean Squared Error

- Used primarily for regression tasks (continuous output)
- Provides a scalar error for an entire sample
- Model predictions look like (potentially scaled) continuous values of a function

Cross Entropy Loss/Softmax

- Used primarily for classification tasks (probability output)
- Provides a scalar error for an entire sample
- Model predictions look like 0-1 scores for each class

Common Ways to Use Loss

Cumulative

- How is the model doing holistically

Running Average

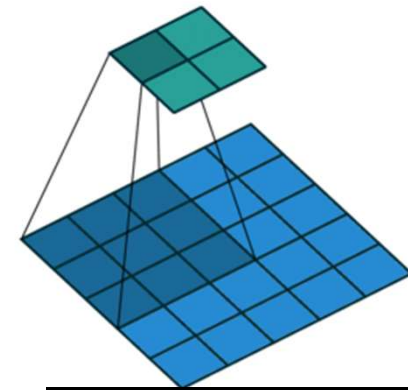
- How is the model doing on an average sample (training step)

Single sample

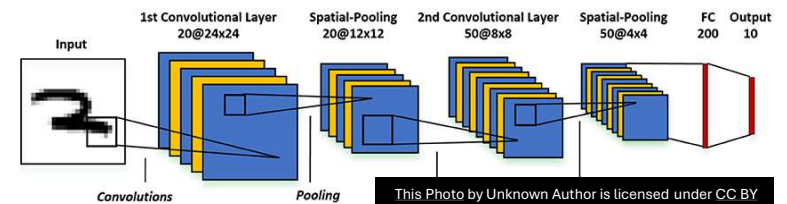
- How well does the model predict this one sample

Convolutional Neural Network

- Stores features in “filters”
- Convolves image into feature space, preserving locality
 - Kernel passed over image “searches” for feature



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Convolution as matrix operation

feature extraction with a sliding window

2	1	3	1	4
4	1	0	1	3
1	3	1	1	1
2	6	1	1	1
3	3	1	0	4



1	2
-1	3



$$2 \times 1 + 1 \times 2 + 4 \times (-1) + 1 \times 3 = 3$$

3			

Some Common Image Operations

Identity

Shifting

Averaging

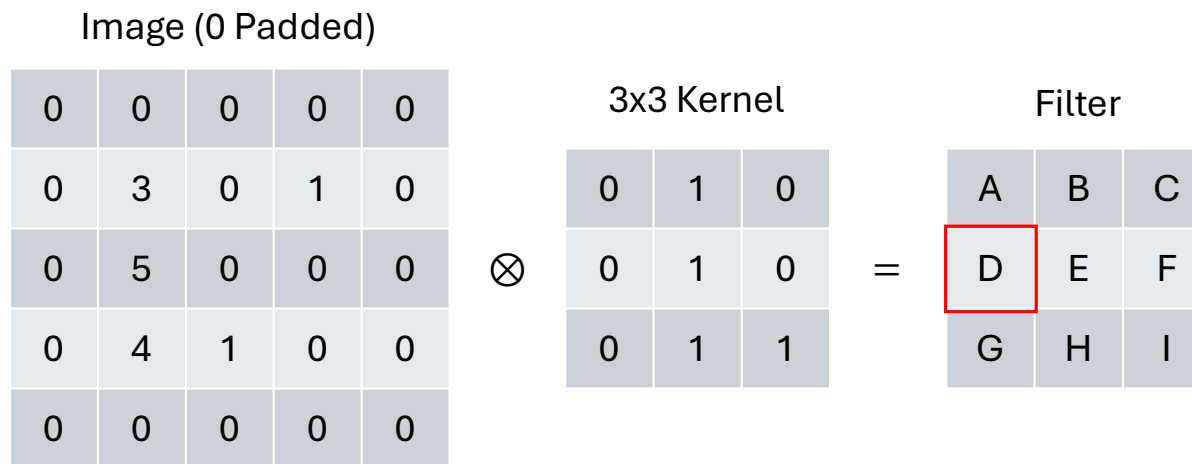
Blur

Differentiation

Correlation

Convolution

Feature Extraction



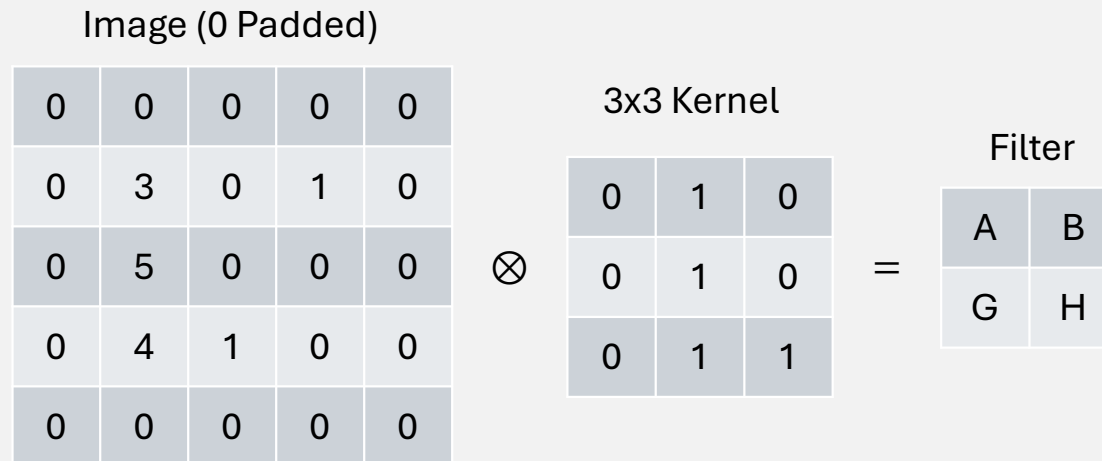
Padding

- What happens if we don't include the zeros in the before example?

Image				3x3 Kernel				Filter
3	0	1		0	1	0		
5	0	0	\otimes	0	1	0	=	E
4	1	0		0	1	1		

Stride

What if I set my stride to 2?



$$D_0 = \frac{D_I - k + 2p}{s} + 1$$

Max Pooling

- What happens if we don't include the zeros in the before example?

Image

3	0	1
5	0	0
4	1	0

=

2x2 Output

5	1
5	1

$$D_0 = \frac{D_I - k}{s} + 1$$

Demo

<https://colab.research.google.com/drive/14S1aRsakVigBv3GaLB2tptkdINz0svYj?usp=sharing>