

Deep Learning

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1 Data Augmentation

2 What is Convolutional Neural Network?

- Images:

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1 Data Augmentation

2 What is Convolutional Neural Network?

What is convolution?

Definition 1

Convolution of the functions $f, g : \mathbb{R} \rightarrow \mathbb{R}$ is defined as the integral of the product of the two functions after one is reversed and shifted:

$$(f * g)(t) =: \int_{-\infty}^{+\infty} f(x) g(t - x) dx.$$

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Definition 2

Convolution of the sequences of real numbers $\{f_n\}_{n=-\infty}^{+\infty}$, $\{g_n\}_{n=-\infty}^{+\infty}$ is the following sequence:

$$z_n =: \sum_{k=-\infty}^{+\infty} f_k g_{n-k}.$$

Definition 3

Convolution of the functions $f, g : \mathbb{R}^2 \rightarrow \mathbb{R}$ is the following function:

$$(f * g)(t, \tau) =: \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} f(x, y) g(t - x, \tau - y) dx dy.$$

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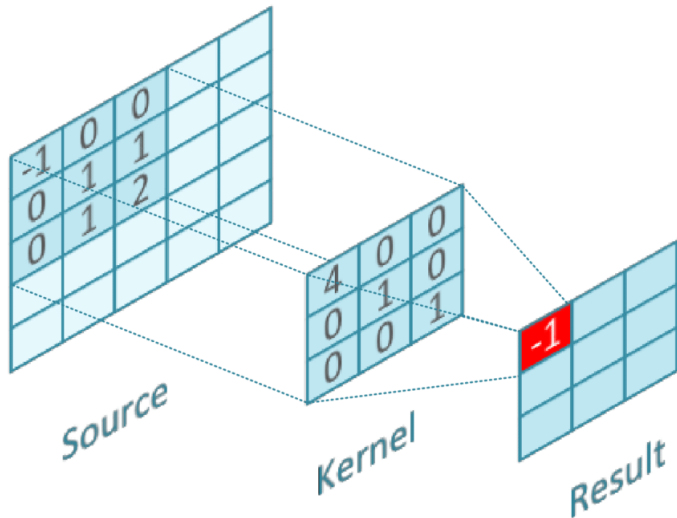
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Definition 4

Let $f(x, y)$ is an image and $w(s, t)$ is a kernel where $s \in [-a, a]$, $t \in [-b, b]$, $x, y, s, t, a, b \in \mathbb{Z}$. The convolution between kernel w and image f is the following function

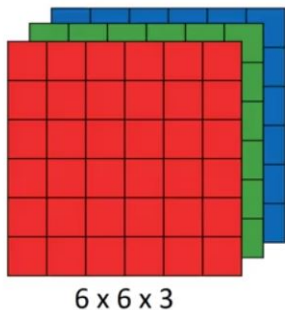
$$(w * f)(x, y) = \sum_{s=-a}^a \sum_{t=-b}^b w(s, t) f(x - s, y - t)$$

2D Convolution

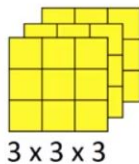


Convolution on RGB Images

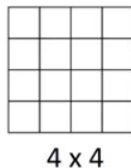
Convolution on RGB Images



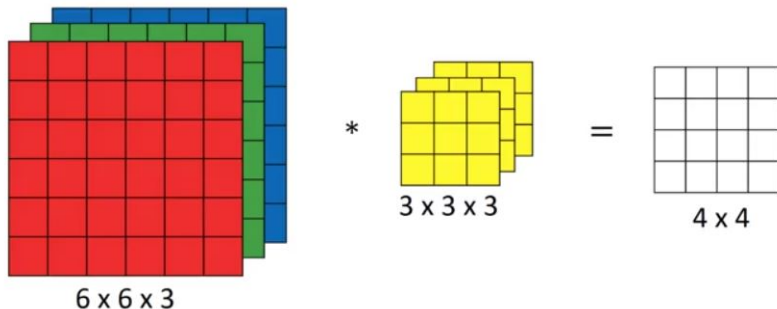
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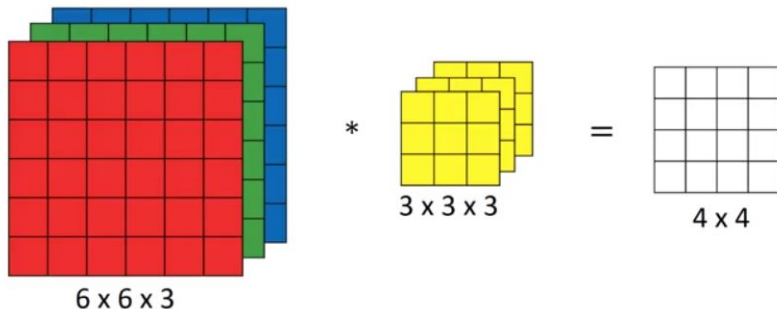


Convolution on RGB Images



- How many dimensions has convolution kernel in general?

Convolution on RGB Images



- How many dimensions has convolution kernel in general?
- What does 1×1 convolution do?

Valid and Same Convolution

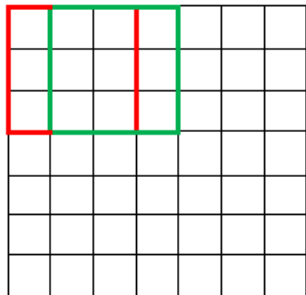
- Padding = Same: means the input image ought to have zero padding so that the output in convolution doesn't differ in size as input.

Valid and Same Convolution

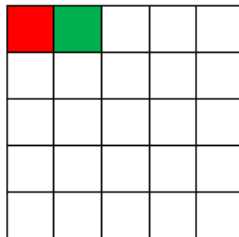
- Padding = Same: means the input image ought to have zero padding so that the output in convolution doesn't differ in size as input.
- Padding = Valid: means we don't add the zero pixel padding around the input matrix, and its like saying, we are ready to loose some information.

Strided Convolution

7 x 7 Input Volume

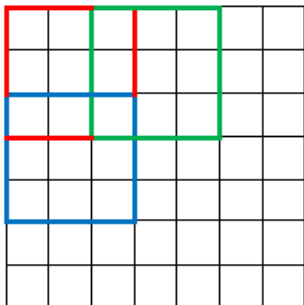


5 x 5 Output Volume

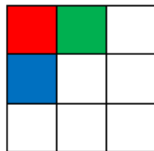


Strided Convolution

7 x 7 Input Volume



3 x 3 Output Volume



One Layer of CNN

