Pooling Layers

Pooling is a fundamental operation in Convolutional Neural Networks (CNNs) that plays a crucial role in downsampling feature maps while retaining important information.

In this blog post, we'll explore the concept of pooling in CNNs, its significance, and the different types of pooling techniques used in practice.

Pooling, also known as subsampling or downsampling, is a technique used in CNNs to reduce the spatial dimensions of feature maps while retaining essential information. It helps in controlling the model's complexity, reducing overfitting, and improving computational efficiency by reducing the number of parameters and computation required in subsequent layers.

The pooling operation involves sliding a two-dimensional filter over each channel of feature map and summarising the features lying within the region covered by the filter.

For a feature map having dimensions **nh x nw x nc**, the dimensions of output obtained after a pooling layer is

(nh - f + 1) / s x (nw - f + 1)/s x nc

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where,

-> nh - height of feature map
-> nw - width of feature map
-> nc - number of channels in the feature map
-> f - size of filter
-> s - stride length

filter of size 2 by 2 with stride of 1 by 1

filter of size 3 by 3 with stride of 1 by 1

filter of size 3 by 3 with stride of 2 by 2

filter of size 2 by 2 with stride of 2 by 2

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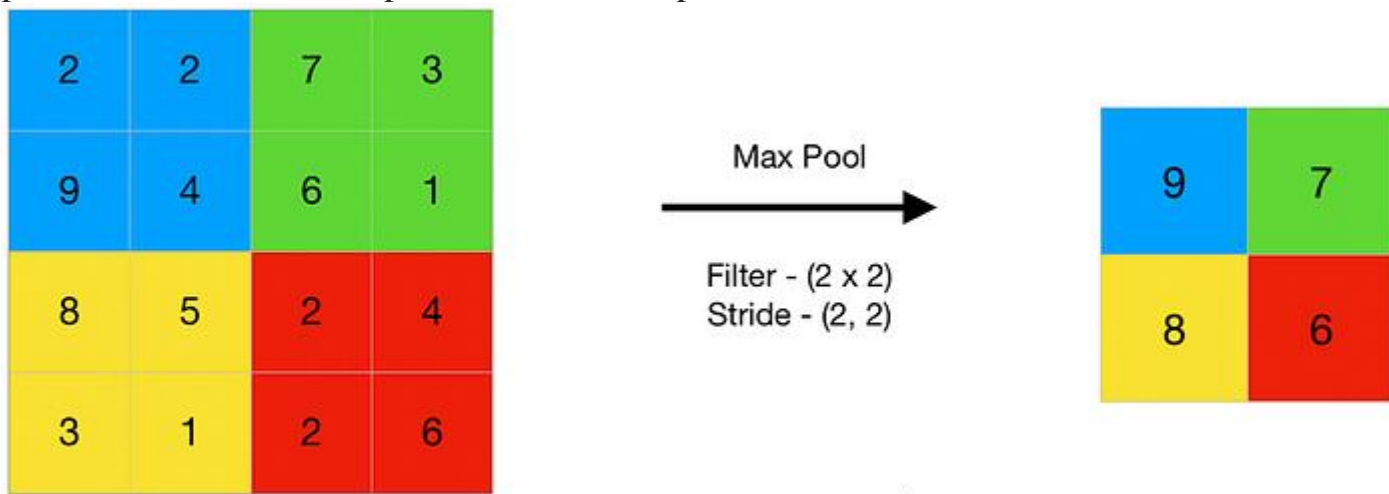
Types of Pooling Layers:

Max Pooling

Max pooling is a pooling operation that selects the maximum element from the region of the feature map covered by the filter.

Thus, the output after max-pooling layer would be a feature map containing the most prominent features of the previous feature map.

Average Pooling

Average pooling computes the average of the elements present in the region of feature map covered by the filter.

Thus, while max pooling gives the most prominent feature in a particular patch of the feature map, average pooling gives the average of features present in a patch.
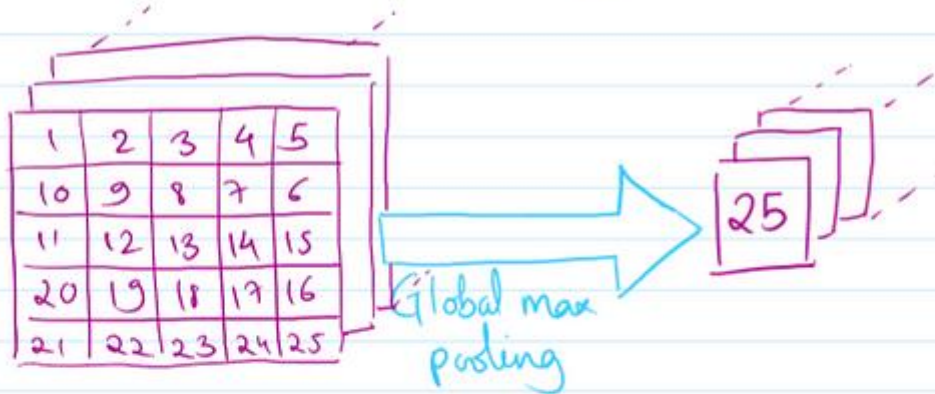
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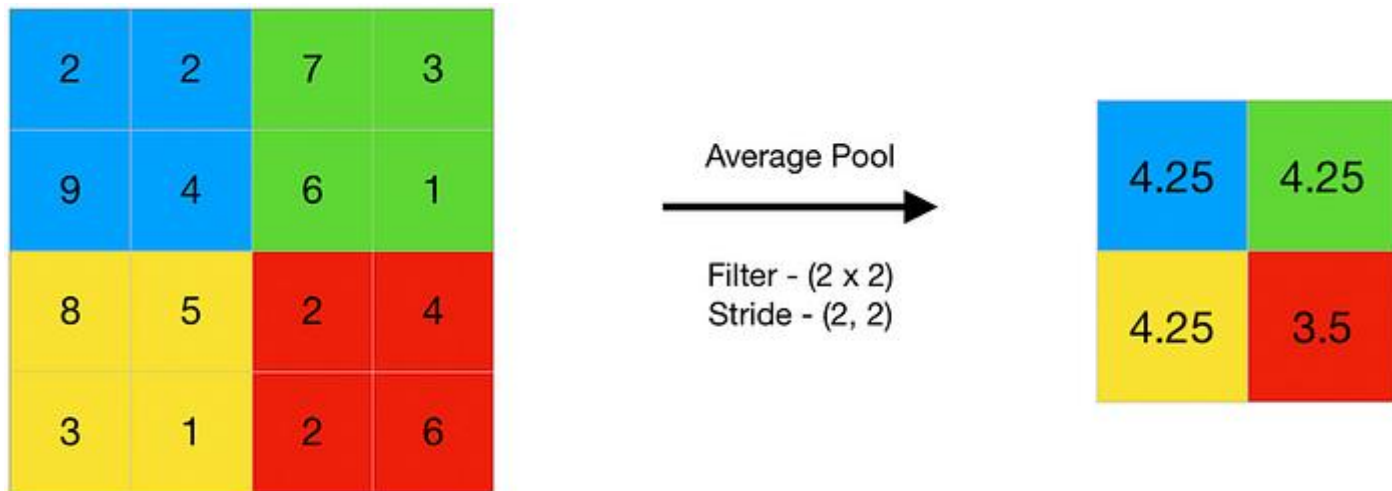
Global Pooling

Global pooling reduces each channel in the feature map to a single value. Thus, an **nh x nw x nc** feature map is reduced to **1 x 1 x nc** feature map. This is equivalent to using a filter of dimensions **nh x nw** i.e. the dimensions of the feature map.

Further, it can be either global max pooling or global average pooling.

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Global Max Pooling

1	2	3	4	5
10	9	8	7	6
11	12	13	14	15
20	19	18	17	16
21	22	23	24	25

Global max pooling → 25

Global Average Pooling

1	2	3	4	5
10	9	8	7	6
11	12	13	14	15
20	19	18	17	16
21	22	23	24	25

Global Avg Pooling → 13

$$\frac{1+2+\ldots+25}{25} = 13$$

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