ARTIFICIAL INTELLIGENCE AND DEEP LEARNING

WEEK 7
2021 SPRING

CHAPTER 3: Deep Learning Models
3.1 Convolutional Neural Networks

- Convolutional Neural Networks are a special type of Artificial Neural Networks (ANNs). Furthermore, they are the most frequently used deep learning architecture.

- Convolutional Neural Networks are frequently used in image processing problems and propose considerably effective solutions in this field.

- In Convolutional Neural Networks, the data is provided to input directly. The neural network realizes the important properties of the data by itself. This property is the most important one differentiating them from normal ANNs.

- Thanks to this approach, Convolutional Neural Networks are able to perform image classification even better than humans.

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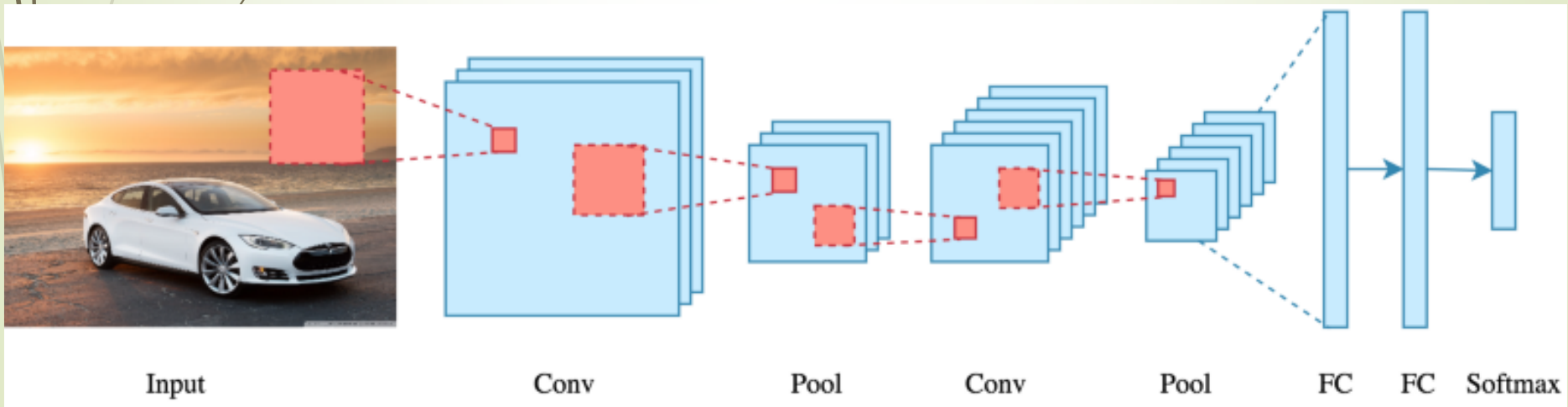
- The architecture of Convolutional Neural Networks are as presented below. Convolutional Neural Networks employ convolution and pooling opeators.



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- In Convolutional Neural Networks convolution+pooling is applied multiple times consecutively .

- In Convolutional Neural Networks this layer is followed by the fully connected layer.

- In classification problems, to improve the effectiveness of the neural network, a layer named softmax is employed at the last stage.

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- The main block in Convolutional Neural Networks is the convolution block.
- Convolution is a mathematical operator that provides merging of two matrix sets.
- The feature map is formed by application of convolution filter to input layer.

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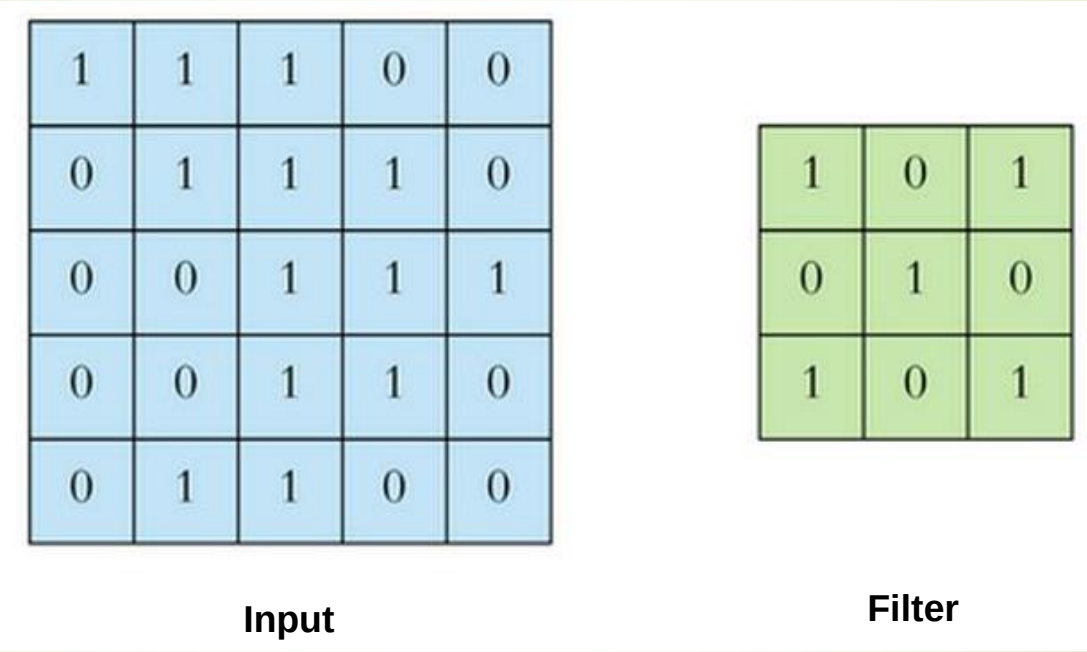

- A two dimensional (5x5) sample input matrix and a convolution filter matrix (3x3) is given above.

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- Convolution operation is realized by sliding the filter over the input.
- On the basis of each element, the elements corresponding to the feature map matrix are formed as a result of matrix multiplication.
- In the next slide, two dimensional representation of this process is given.

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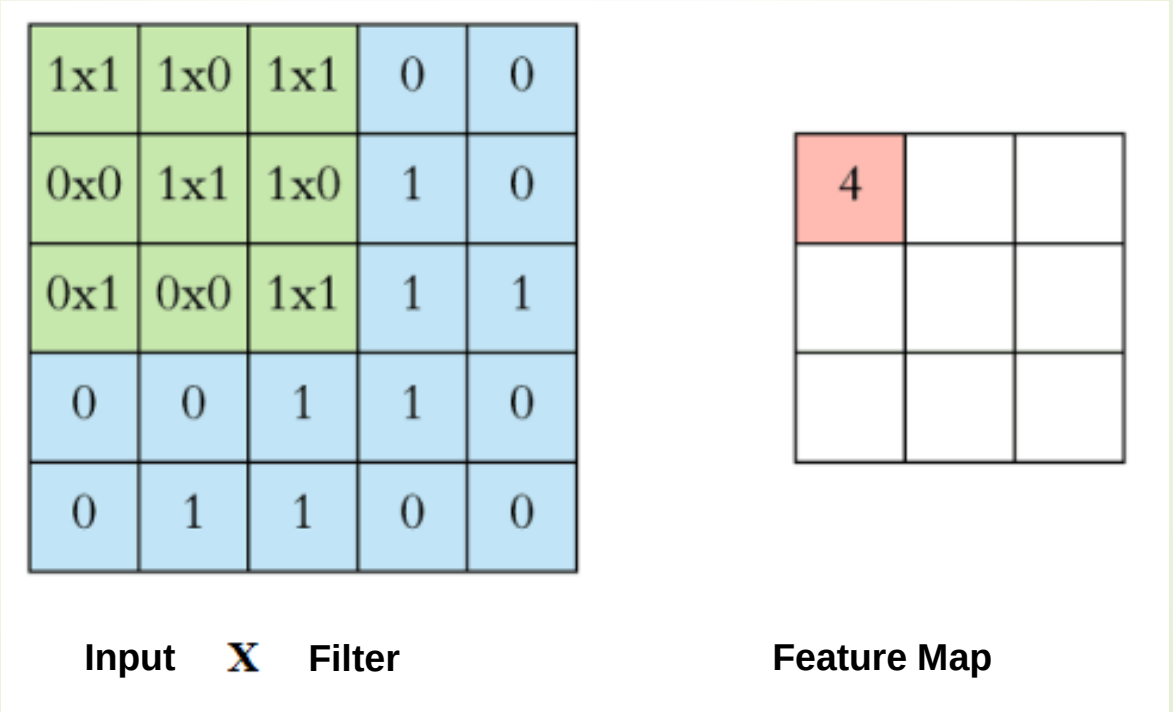

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- In real applications the image is represented in three dimensions as height, width and depth.
- Depth denotes the Color channels in the image. In images of RGB format, the depth is considered as 3 channels.
- Multiple and different convolution filters can be processed for the input matrix. In this case, feature maps will also be shaped differently.
- At this stage, all feature maps can be merged to obtain a single feature map.

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- In the example on next slide, an 32x32x3 image is convolved with a filter matrix of size 5x5x3 .
- In this operation, for each layer 3 matrices of size 5x5x1 are merged to obtain a value of size 1x1x1.
- The convolution layer obtained as a result of these processes will be of size 32x32x1 .
- If 10 different filters are used in these processes, the convolution layer will be of size 32x32x10 .

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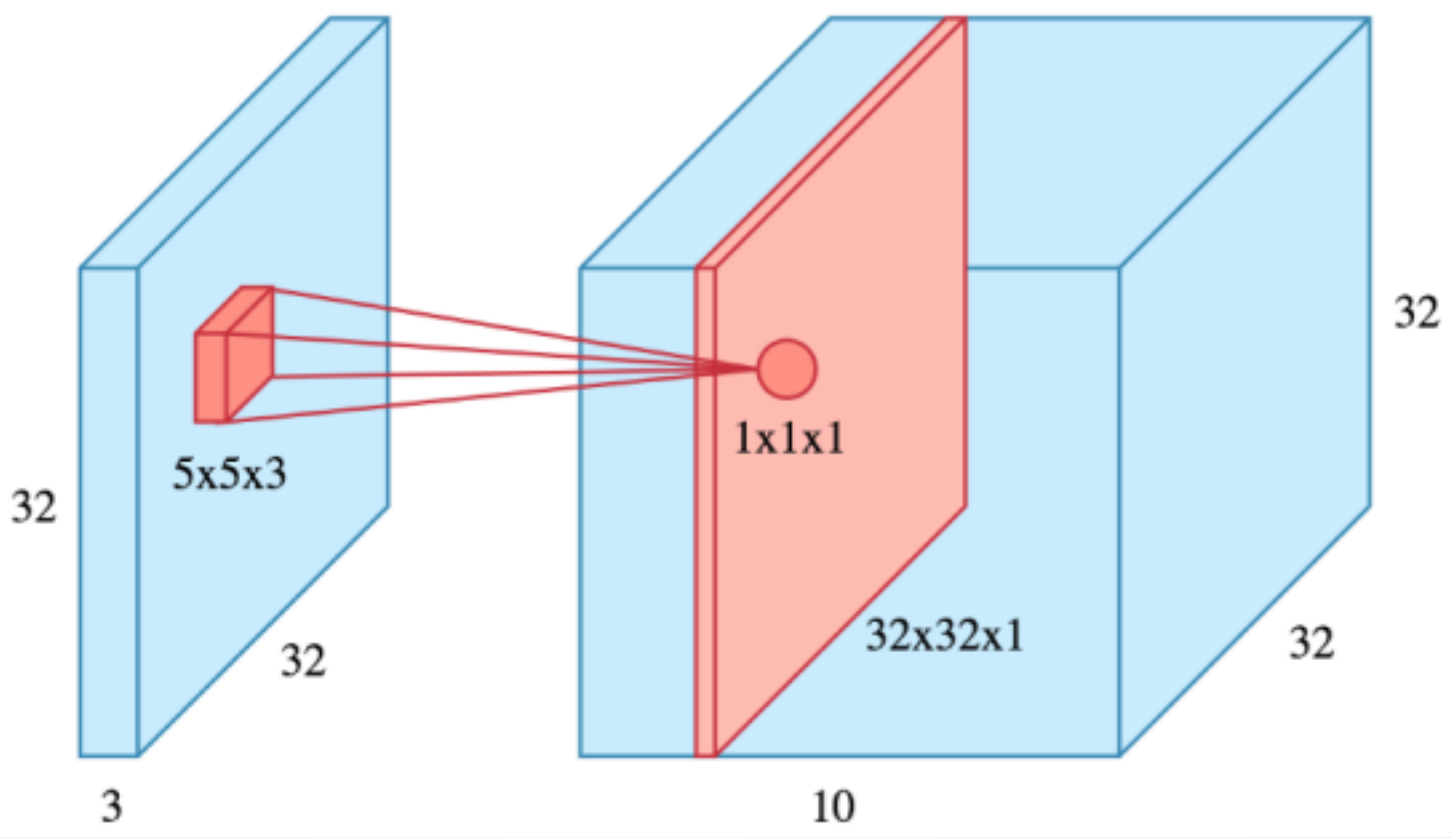

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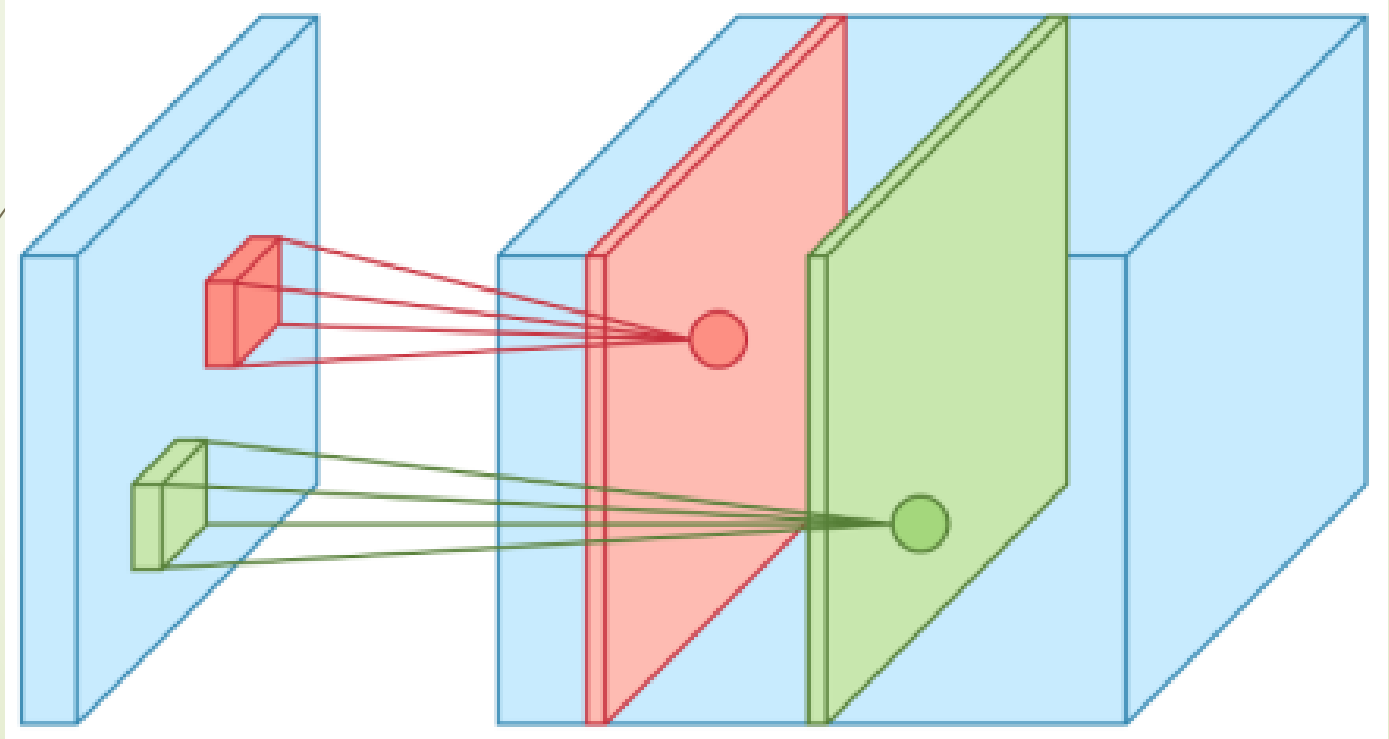
- The feature map is obtained by sliding the filter over the whole input.



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- Convolutional Neural Network is required to satisfy the nonlinearity property.
- In ANNs and Autoencoder Neural Networks, the nonlinearity is provided by activation functions.
- For Convolutional Neural Networks to gain this property, the results of the convolution operator is transferred to the activation function.
- In the next slide some activation functions used in this constext are illustrated.

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