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Machine Learning for Computer Vision
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Topic: Neural Networks and Deep Learning

Exercise 1: Neural Networks

a) *Write the general formula of the transformation that a fully-connected layer performs on its inputs.*

b) *Write the general formula of the transformation that three fully-connected layers perform on their inputs.*

c) *What would be the disadvantage of not having a nonlinearity? What would the output of a three-layer perceptron be?*

d) *Draw a three-layer perceptron with arbitrary numbers as input values and weights, and choose arbitrary nonlinearities. Write the weights as matrices, and also write them next to the respective arrows in the drawing. Compute the outputs.*

Exercise 2: Deep Learning

a) *Write the general formula of the transformation that a 1D convolutional layer performs on its inputs.*

b) *Compute the result of a 1D convolutional layer with several input channels and several filters. Write arbitrary numbers as inputs and weights. Consider also the 2D case.*

c) *Design an edge-detecting filter.*

What should its output be in regions with constant input image intensity?

What property should an edge-detecting filter therefore have?

d) *Compute the receptive field of a three-layer 1D convolutional network with filter size 3 in the first layer, filter size 7 in the second layer, and filter size 7 in the third layer.*

If the input to this network has length 100 and 10 channels, what can be said about the length and number of channels of the output?

What happens with the last entry of the output, if the first entry of the input is increased by 1*? Why?*

e) *What two properties of feature extraction does a convolutional layer have?*

f) *Why do deep neural networks yield better results on certain datasets than shallow neural networks?*