Computer Vision 1, Master AI
Tutorial Lecture 5: ConvNets

Amir Ghodrati and Thomas Mensink and Theo Gevers

1 Conv Layer Arithmetics

1.a How many parameters are needed for a fully connected layer, with the following configurations: Input Width (W) = 100 nodes, the Input Height (O) = 100 nodes, and Hidden Layer (H) = 1000 nodes? Note: Here an image of the mentioned dimensions are flattened out.

1.b How many parameters are needed for a locally constrained layer, where each neuron looks at a 10x10 window, when using W=H=100, and stride of 5?

1.c How many parameters are needed when a convolutional layer is used, using a filter of size 10x10, and using 100 different filters?

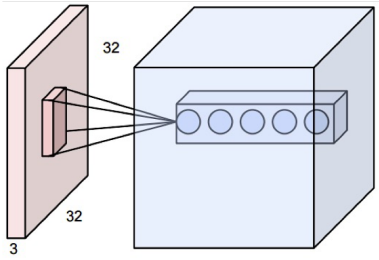

Figure 1: Input volume: $32 \times 32 \times 3$, receptive field: 5×5, number of neurons: 5, along the depth dimension

1.d What is the size of the output volume with stride 1?

1.e How many weights are learned in one filter? How many in this layer?

1.f What is the depth of a filter in the next layer?

1.g What is the size of the output volume with stride 3?

1.h How many weights are learned in that case?

2 Sharing of Weights

2.a Describe a scenario where weight sharing -as is done in the Convolutional Layer - is not beneficial for recognition or training.

3 Gradients

3.a What is the difference between the analytical gradient and the numerical gradient?

3.b Consider the following conv notation: $a_{rc} = \boldsymbol{x}_r^\top \boldsymbol{\theta}$, what is the gradient wrt the parameters?

3.c Consider the ReLu non-linearity $z = \max(0, a)$, what is the gradient?

3.d A ReLU is considered to be 'dead' if it never updates. Describe (a) when this happens, and (b) one method to circumvent dead ReLUs

3.e Describe the max-pooling layer, and the gradient of the layer

4 Transfer Learning and Invariances

4.a

	very similar new data	very different new data
very little new train data	**A**	**C**
quite a lot new train data	**B**	**D**

Given a pre-trained network, with a new set of data that you want to train a classifier on, please give an advise about learning scheme for a ConvNet scheme for the 4 scenarios (**A-D**) above.

4.b How could you test the invariance of a convnet towards rotation?