

## Homework 2: Convolutional Networks

Due date: **27.03.2019**, presented at the lab

Total: 100 points:  $\min(100, \text{score})$

For this homework you will design and train a convolutional network capable of counting the digits in an image. You will get a dataset of 5000 training images and 1000 testing images, each of size 100x100. These images are formed by placing  $N$  (1 to 5) digits from the MNIST dataset (28x28 digits) onto a noisy background. The goal is to predict the number of digits in the image.

The dataset is found in the course Google Drive folder in `mnist_count_test.pickle` and `mnist_count_train.pickle`.

You must implement two methods for this task:

**Method 1: [50 points]:** Without training on the counting dataset.

Just use a model trained to classify images on MNIST dataset. Use this model in a sliding window approach or by converting it to a fully convolutional network to predict maps representing the probability of digits being present at that location. Using this maps, with no additional training estimate the number of digits.

**Method 2: [80 points]:** Train a new convolutional network to predict the number of digits. Investigate the usefulness transfer learning by reusing the first part of the classification MNIST network. Train a model using parameters from the pretrained classification model and a model with all the parameters randomly initialized.

Your task is to investigate the best network architecture for this tasks, the appropriate loss (mean square error or cross-entropy), the effect of transfer learning.