MSE | MASTER OF SCIENCE IN ENGINEERING

HES-SO

Machine Learning

Practical work 09 - Deep Neural Networks

Teachers: A. Perez-Uribe (Email: andres.perez-uribe@heig-vd.ch) & J. Hennebert
Assistant: H. Satizabal (Email: hector-fabio.satizabal-mejia@heig-vd.ch)

Summary for the organization:

- Submit the solutions of the practical work before Monday 4.12.17 23h55 via Moodle.
- Modality: PDF report (max. 4 pages)
- The file name must contain the number of the practical work, followed by the names of the team members by alphabetical order, for example 09_dupont_muller_smith.pdf.
- Put also the name of the team members in the body of the notebook (or report).
- Only one submission per team.

0. Notebooks and libraries

Download the notebook material from the Moodle platform and install TensorFlow and Keras libraries. Keras is a high-level neural networks library, written in Python and capable of running on top of either TensorFlow or Theano. Its primary author and maintainer is François Chollet.

1. Digit recognition from raw data

The objective of this exercise is to train a shallow neural network using the raw pixel data of the MNIST digit database. Each digit input is an image of 28x28 pixels and there are 10 classes: digits 0 to 9.
Study the notebook « MLP_from_raw_data.ipynb » and play with the code to solve this benchmark classification task. Compare the results obtained by various neural network configurations and diverse parameters. Select a final model (e.g., the one with better performancel) for analysis (please, see below the summary of work to include in the report).

2. Digit recognition from features of the input data

The objective of this exercise is to train a shallow neural network using features computed from the raw pixel data of the MNIST digit database. Instead of using as input the 28x28 pixel images, we compute the Histogram of gradients (HOG) features of parts of the image (e.g., sliding windows) and use those features as inputs to the neural network.

Study the notebook “MLP_from_HOG.ipynb” and play with the code. Compare the results obtained by using various neural network configurations, diverse parameters of the learning and of the feature extraction phase. Finally compare the results with the previous section and select a final model (e.g., the one with better performancel) for analysis (please, see below the summary of work to include in the report).

3. Convolutional neural network digit recognition

The objective of this exercise is to train a deep convolutional neural network capable of “automatically” determining the features (e.g., thanks to the supervised learning process) that allow it to properly recognize the digits 0 to 9.

Study the notebook “CNN.ipynb” and play with the code. Compare the results obtained by using various neural network configurations, filter sizes, number of filters per layer, using or not dropout and compare the obtained results with the previous two sections. Select a final model (e.g., the one with better performancel) for analysis (please, see below the summary of work to include in the report).

Summary of work to include in the report

1. What is the learning algorithm being used to train the neural networks ? What are the parameters (arguments) being used by that algorithm ? What cost function is being used ? please, give the equation(s).

2. Model complexity: for each experiment (shallow network learning from raw data, shallow network learning from features and CNN), select a neural network topology and describe the inputs, indicate how many are they, and how many outputs. Compute the number of weights of each model (e.g., how many weights between the input and the hidden layer, how many weights between each pair of layers, biases, etc..) and explain how do you get to those values.

3. Are the deep neural networks much more complex than the shallow ones ? explain with an example.

4. Test every notebook for three different meaningful cases, describe the model and present the performance of the system (e.g., plot of the evolution of the error, final evaluation scores and confusion matrices). Comment the differences in results. Are there particular digits that are frequently confused ?