MSE | MASTER OF SCIENCE IN ENGINEERING

HES-SO

Machine Learning

Practical work 10 - Artificial Neural Networks (ANN)

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Summary for the organization:

Submit the solutions of the practical work before Tuesday 25.11.25 12h00 via Moodle.

- Modality: PDF report (max. 8 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

Download the notebook material from the Moodle platform

1. The Perceptron and the Delta rule

Read each notebook material (see list below), follow the instructions, play with the code, program the proposed problems and answer the questions.

List of notebooks associated with this exercise:

1_activation_function.ipynb
2_perceptron.ipynb
3_delta_rule_points.ipynb

Known issue: "MovieWriter ffmeg unavailable"
Solution: install ffmpeg by using the command: conda install -c conda-forge ffmpeg.
If it is still not working, change the flag to SHOW_VIDEO = False.

2. Backpropagation

Read each notebook material, follow the instructions, play with the code, program the proposed problems and answer the questions.
List of notebooks associated with this exercise:

4_backpropagation_MLP.ipynb

3. Cross validation

Please, read each notebook material, follow the instructions, play with the code: e.g., modify the number of hidden neurons, the datasets, the number of k for cross-validation, etc.

List of notebooks associated with this exercise:

5_cross_validation.ipynb

4. Model building

When training a neural network to solve a problem, e.g., to develop a classification system, you will need to evaluate diverse models (neural net configurations, complexities, diverse parameters, etc.) and select the "best" one. The following notebook presents a methodology iterating over the number of epochs (learning duration) and number of hidden neurons (model complexity). When selecting the final model, that is, defining the number of epochs for training and the number of hidden neurons, you will need to evaluate the performance of the final model, by cross validation, and you might also compute the confusion matrix, which illustrates if the system confuses certain inputs while attempting to classify them.

List of notebooks associated with this exercise:
6_model_selection.ipynb

5. Building MLP Models using Keras Library

Build MLP models using the Keras library and tune hyperparameters (e.g., number of neurons, layers, learning rate, …). Test the models on three types of datasets: balanced with clear separation, balanced with mixed classes, and unbalanced. Select and present the **three best experiments** (with tuned hyperparameters) for each dataset. For each experiment, provide results such as confusion matrices and other relevant metrics. Analyze the impact on loss, convergence, computation time, and overfitting.

List of notebooks associated with this exercise:

7_mlp_keras.ipynb

Summary of work to include in the report

- Answer questions 1-3 from the 3_delta_rule_points notebook and present the resulting plot when the option SHOW_VIDEO is set to False.
- Run notebook 5, provide the final plots *MSE vs spread* and comment the difference between results.
- Run notebook 7 and provide the chosen hyperparameters for each of the three dataset types. Test on three dataset types: balanced with clear separation, balanced with mixed classes, and unbalanced. Present the top three experiments per dataset with metrics like confusion matrices and summarize your findings.