Training strategies of Multilayer Perceptron network for study in three-phase flow

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This report presents a methodology based on nuclear techniques combined with artificial neural network (ANN) that have been used in order to predict fluid volume fractions (FVFs) using data obtained from gamma-ray radiation detectors. This research proposes investigations and comparisons of training strategies based on dual-modality principles using two NaI(Tl) detectors [1]. The training and validation patterns were obtained by means of mathematical models for stratified regime using the MCNPX code [2]. This code is used for simulating electron and photon transport through materials with various geometries. The MCNPX code considers the main effects of radiation interaction with matter involved (oil, water and gas) and the pulse height distributions (PHDs) from the real NaI(Tl) detectors, the model simulated tends to approach the realistic case. In this research, a 5-layer MLP has been investigated. After training phase of the ANNs, the operation was evaluated with the validation set (data not comprised in the training, nor in the test set). Three ANNs setups of input data, for MLP and GRNN, have been used:

i) ANN1 (106 neurons): All PHDs (PHD1 e PHD2).
ii) ANN2 (28 neurons): peak regions: a) 20 keV to 80 keV – (^{241}Am); b) 600 keV to 720 keV – (^{137}Cs) of PHD recorded at D1; c) Peak located in 20 keV to 90 keV recorded at D2.
iii) ANN3 (3 neurons): Integral of previous three peaks (photon counts). The ANN outputs were H_2O and gas volume fraction, that is, the outputs equal 2 neurons.

Figure 1 shows the relative error between the volume fractions predicted by the ANNs and the real one for all patterns. The Table 1 show the FVF predictions from MLPs and GRNNs networks respectively. The results show the three Multilayer perceptron (MLP) networks have the same qualities. However, it is recommended to use the MLP3 that uses integral three peaks, which has an intermediary training time and uses a single-channel analyzer.

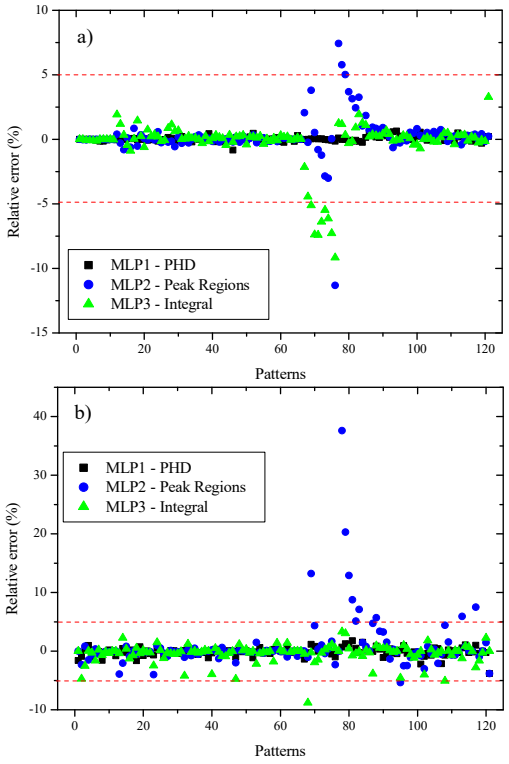

Figure 1. The relative error of MLP networks for the all patterns for: a) water, b) gas.

Table 1. Summary of pattern recognition for the MLP3 prediction.

Data	gas	water
≤ 5%	85.124	80.992
5% - 10%	5.785	1.653
10% - 20%	0	0
20% - 30%	0	0
> 30%	0	0
r^2	0.9999	0.9999

References

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