Comparison of Supervised and Unsupervised Learning in AI-based analyses of carbon steel weld phased-array ultrasound data

Richard Rheaume[1], Étienne Drouin-Provencal[1], Yan-Éric Cossette[1], Lina Maria Strack[1]

[1]R&D, Ondia, Canada

Training an Artificial Intelligence (AI) model can be a complex task. Several factors can influence the quality of the training and thus the performance of the AI model. For example, the objectives of the training must be clear, a dataset of sufficient size must be available, and the type of data in the training set must reflect what will be analysed later. Even if those factors are respected, special care must be taken when choosing the data to avoid unwanted bias. Depending on the size of the dataset, its variability and type, two types of learning methods can be used: supervised and unsupervised. In supervised learning (SL), the training of an AI model requires many hundreds or thousands of labelled examples, which describe the output that the AI model needs to classify. The AI model uses theses labelled examples to learn which output corresponds to a given input, and it is strongly dependent on the quality of the labelled examples. In the Non-Destructive Testing (NDT) industry, most of the available data would be labelled as “normal data”. This means that these examples do not include anomalies (i.e., welding defects), and therefore cannot be used to train a SL model to automatically identify defects. Unsupervised learning (UL), on the other hand, is the process of training AI models without using labelled examples. This type of training is based on learning what represents “normal examples”. Once the AI model knows what “normal data” looks like, it can then detect anomalies, which correspond, in this case, to the welding defects. Training an AI model using UL is therefore an important step forward in NDT, as it allows the use of much more data (i.e., “normal data”) without additional cost. Using UL in this industry allows efficient models to be trained and to be readily available for use much more quickly. Preliminary results show that the SL method is generally better at segmenting welding defects. UL not only achieves better results than SL with rare defects, but it also has better generalization capability, resulting in better results than SL when it encounters “abnormal” data. In this paper, we compare the detection performance of two AI models: one that used SL, and another that used UL. The AI model is meant to analyse data acquired during the inspection of welds with phased-array ultrasound and determine potential welding defects. For each learning method, we use the same data. To compare the efficiency of the two learning methods, we compare the results using new unseen data.