Optimisation of a Neural Network for Dark Matter Research

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The make-up of dark matter, which contributes about 30% to the universe’s matter-energy contribution, is one of the most puzzling mysteries and active areas in contemporary physics research. Current dark matter experiments face the issue of increased background noise due to the high sensitivity their research objectives demand. While traditional ways of filtering out background noise are developed to their limits, this project explores the potential of a multi-layer perceptron, a form of narrow artificial intelligence, to analyse empirical data taken by a running astroparticle physics experiment searching for dark matter. After determining the most suitable network type and network structure, different hyperparameters were varied independently. Self-programmed applications visualising the network’s performance were the main tool to analyse the effect of these variations and make decisions about further variations. In this manner, the influence of hyperparameters such as the optimiser, training duration, learning rate, loss and activation function as well as multiple regularisation methods on the network’s performance were investigated. Variation of the set of input parameters which were used for training the network as well as several techniques for normalisation and scaling were tested in order to reduce the large variance observed in the input data. Finally, an accuracy of ca.99.61% was achieved. For future application, the network would, for example, be trained significantly longer and with more data than currently available for this project. These easy-to-make changes will certainly enhance the network’s performance further. In summary, this approach is shown to be a highly promising alternative to the present analysis methods for future data evaluation.

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