EGU23-946, updated on 20 Apr 2024
https://doi.org/10.5194/egusphere-egu23-946
EGU General Assembly 2023

Combining Bayesian Neural Networks with explainable AI techniques for trustworthy probabilistic post-processing

Mariana Clare, Zied Ben Bouallegue, Matthew Chantry, Martin Leutbecher, and Thomas Haiden
ECWMF, Reading, UK (mariana.clare@ecmwf.int)

The large data volumes available in weather forecasting make post-processing an attractive field for applying machine learning. In turn, novel statistical machine learning methods that can be used to generate uncertainty information from a deterministic forecast are of great interest to forecast users, especially given the computational cost of running high resolution ensembles. In this work, we show how one such method, a Bayesian Neural Network (BNN), can be used to post-process a single global high resolution forecast for 2m temperature. This methodology improves both the accuracy of the forecast and adds uncertainty information, by predicting the distribution of the forecast error relative to its own analysis.

Here we assess both model and data uncertainty using two different BNN approaches. In the first approach, the BNN's parameters are defined to be distributions rather than deterministic parameters, thereby generating an ensemble of models that can be used to quantify model uncertainty. In the second approach, the BNN remains deterministic but predicts a distribution rather than a deterministic output thereby quantifying data uncertainty. Our BNN results are benchmarked against simpler statistical methods, as well as statistics from the ECMWF operational ensemble.

Finally, in order to add trustworthiness to the BNN predictions, we apply an explainable AI technique (Layerwise Relevance Propagation) so as to understand whether the variables on which the BNN bases its prediction are physically reasonable or whether it is instead learning spurious correlations.