Geophysical Research Abstracts
Vol. 18, EGU2016-4545, 2016
EGU General Assembly 2016

Online probabilistic learning with an ensemble of forecasts

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Our objective is to produce a calibrated weighted ensemble to forecast a univariate time series. In addition to a meteorological ensemble of forecasts, we rely on observations or analyses of the target variable. The celebrated Continuous Ranked Probability Score (CRPS) is used to evaluate the probabilistic forecasts. However applying the CRPS on weighted empirical distribution functions (deriving from the weighted ensemble) may introduce a bias because of which minimizing the CRPS does not produce the optimal weights. Thus we propose an unbiased version of the CRPS which relies on clusters of members and is strictly proper.

We adapt online learning methods for the minimization of the CRPS. These methods generate the weights associated to the members in the forecasted empirical distribution function. The weights are updated before each forecast step using only past observations and forecasts. Our learning algorithms provide the theoretical guarantee that, in the long run, the CRPS of the weighted forecasts is at least as good as the CRPS of any weighted ensemble with weights constant in time. In particular, the performance of our forecast is better than that of any subset ensemble with uniform weights. A noteworthy advantage of our algorithm is that it does not require any assumption on the distributions of the observations and forecasts, both for the application and for the theoretical guarantee to hold.

As application example on meteorological forecasts for photovoltaic production integration, we show that our algorithm generates a calibrated probabilistic forecast, with significant performance improvements on probabilistic diagnostic tools (the CRPS, the reliability diagram and the rank histogram).