Moving Beyond Bayes: On the Combination of Probabilistic Forecasts Given Imperfect Models

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Abstract

A variety of different models are often available from which to form probabilistic forecasts for a given target. It is widely understood that a weighted average can sometimes outperform each of the models individually in terms of probabilistic forecast performance. One question then is how best to select the weightings placed on each model forecast. A common approach is Bayesian Model Averaging (BMA) in which some set of prior weights is chosen, and then updated as new data become available. BMA, however, makes the assumption that exactly one of the models is perfect, that is it can describe the dynamics of the system exactly. In the real world, at best, this is highly unlikely; the assumption is violated. In practice, the weight placed on the model with the highest likelihood always tends to one as the number of data points used to update the prior is increased and thus the information in the other models is ignored asymptotically. In fact, BMA should not be considered a method for finding the optimal combination of models at all, but rather to account for the uncertainty in selection of the best model when only limited data is available.

An alternative approach to forming probabilistic forecasts with multiple models is to blend the models. With this method, the model weightings are chosen to be those that optimise forecast performance over a forecast-outcome archive with respect to some particular scoring rule. The weights are expected to tend towards the optimal weights as the size of the forecast-outcome archive increases. Models from nonlinear dynamical systems are used to show how, whilst BMA outperforms blending when one of the models is indeed perfect, the opposite is true in the more realistic case that each of the models contain some structural model error. These results prove, by demonstration, that using BMA with multiple models is a suboptimal approach to probabilistic forecasting.

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