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A barycenter-based approach for the multi-model ensembling of subseasonal forecasts

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Combining ensemble forecasts from different models into a multi-model ensemble (MME) have been shown to improve forecast skill at different time-scales, including the sub-seasonal to seasonal (S2S) one. Here, we investigate a new method to build such MME based on barycenter.

Recognizing ensemble forecasts as discrete probability distributions, we work directly in the probability distribution space. This allows us to use existing tools in this space, and in particular the concept of barycenter. The barycenter of a collection of distributions (or the ensemble forecasts here) is the distribution that best represents them, based on a given metric. The barycenter can thus be seen as the combination of these distributions, and so used to build a MME. We compare two barycenters based on different metrics: the L2 and the Wasserstein distances. The Wasserstein distance corresponds to the cost of the optimal transport between two distributions and has interesting properties in the distribution space. We compare it to the L2-barycenter which is in fact shown to be equivalent to the well-known “pooling” MME method (i.e. the concatenation of the different ensembles members). Another interesting point of the barycenters is that they allow you to give different weights to the models and so to easily build a weighted-MME. The weights have an important impact on the skill of the MMEs. We are thus optimizing the weights by learning them from the data using cross-validation on the forecasts.

The two barycenter-based MMEs are applied to the combination of the models from the S2S project’s database. Their performances are evaluated for the prediction of weekly 2m-temperature during European winter with respect to different metrics. As a proof of concept, we first start with the combination of two models, namely the European Centre Medium-Range Weather Forecasts (ECMWF) and the National Center for Environmental Prediction (NCEP) models. We show that the two MMEs are generally able to perform as well or better than both the single-models, but that the best combination method depends on the chosen metric. We then extend the barycenter approach to the combination of more models, of which we will discuss preliminary results.