Response to 2nd Review of referee #1 Cajo ter Braak

Many thanks for this second very thoughtful review.

BUMPER additively combines the two models M1 (percentage) and M2 (p/a) in the construction of individual likelihood functions. We need to normalise them before combining because the likelihoods of the two models have different magnitudes by construction. i.e. prob(presence|x) >> prob(percentage|x). A blended likelihood function without this early normalisation would always be dominated by the p/a model.

The approach suggested by the referee is to construct a posterior from each model, and then to combine these posteriors. We agree that in this case the initial normalisation step would not be required. However, the resulting model is quite different. This difference arises because in the suggested case of combining posteriors (and in contrast to BUMPER) there are no cross-terms between the M1 and M2 likelihood functions i.e. because the two models are derived separately and then additively combined.

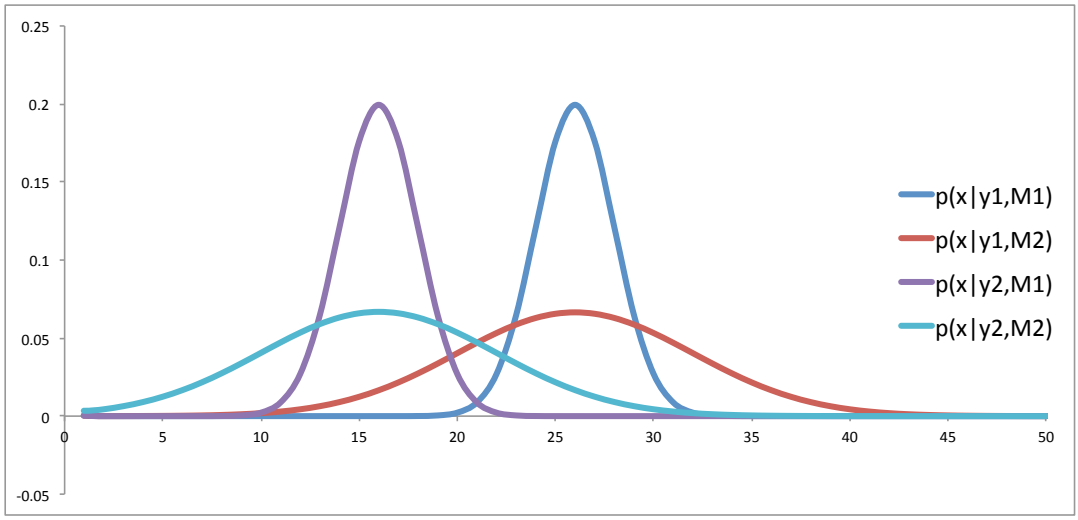
We demonstrate this with an example, plotting overleaf the posteriors from the two approaches, considering idealized likelihood functions of two taxa where (at least) one of them is an outlier (i.e. the M1 likelihood functions do not overlap).

In the existing model ("blended likelihoods"), there are two peaks in the posterior. The philosophy of using a blended likelihood function is to prevent an outlying count (e.g. misidentification) from ruling out the "true" reconstruction. This works because the presence likelihood function is generally much broader, so that very little of the reconstruction space is entirely ruled out. (Note that other taxa will generally act together to favour one of these peaks. The consequence is that the outlier will have a weakened effect on the reconstruction.)

In the alternative model, where M1 and M2 are applied separately and the posteriors are combined, the double peak disappears. In effect this model does not consider the possibility that one of the counts is an outlier and this leaves the central region as the most likely reconstruction.

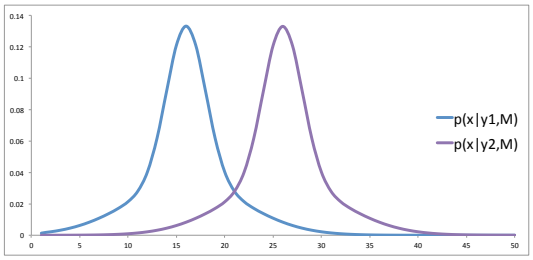
An evaluation of the performance and philosophical differences between these alternative approaches is beyond the scope of this paper, which is focused upon generation of automated priors to allow application to arbitrary proxies, but suggests a potentially interesting avenue for future work.

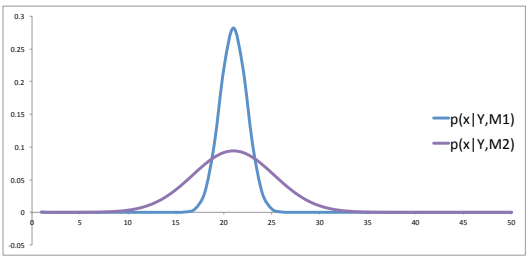
Corrections: We have deleted the "It defines…" sentence (P4 L3), replaced it with a note to clarify the need for early normalization, and have added the suggested comment re total law of probability (P3 L39-40)



Blended likelihoods

Separate models





Posterior (combining blended likelihoods)

Posterior (combining posteriors of two models)