

RECONSTRUCTING PAST LANDSCAPES – SPACE-TIME MODELLING OF COMPOSITIONAL DATA WITH ZERO COUNTS

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Fossil pollen records can be used to understand regional interactions between human land use, past vegetation and climate. A study of fossil pollen covering 45 sites in Southern Sweden during 44 time periods from present to 7000 BC has recently been completed. From these pollen records the local proportions of five land cover types: coniferous and deciduous forest, shrubs, open land and arable land (i.e. human land use), can be extracted. However, for climate modelling and to understand the evolution of human land use it would be desirable to interpolate the data into space-time maps.

Similar reconstructions have previously been done for 5 time periods over Europe using Gaussian Markov Random Fields (GMRFs) and Dirichlett distributions (Pirzamanbein, et. al, 2017). Here we extend the model in Pirzamanbein to handle: 1) spatio-temporal dependencies and 2) absence of some classes.

The Dirichlett model is suitable for the compositional pollen data since it automatically obeys the (0,1) and sum-to-one restrictions of the data. However, the Dirichlett distribution does not handle absence of classes from the distribution, i.e. observations with 0% probability of one class. To handle the zero-probabilities we propose a model that combines Dirichlett and Bernoulli observations of the same underlying GMRF, creating a joint model for presence/absence and proportions of the classes. Allowing us to create maps, and to model the advance of agriculture.

Keywords: Gaussian Markov Random Field, Dirichlett distribution, Fossil pollen, Southern Sweden, past vegetation

References:

Pirzamanbein, B., Lindström, J., Poska, A. and Gaillard, M-J. (2017). Modelling Spatial Compositional Data: Reconstructions of past land cover and uncertainties *arXiv*, 1511.06417v2