

Multivariate Structured Additive Distributional Regression

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Classical regression models within the exponential family framework such as generalised linear models or generalised additive models focus exclusively on relating the mean of a response variable to covariates but neglect the potential dependence of higher order moments or other features of the response distribution on covariates. As a consequence, the advantage of obtaining covariate effects that are straightforward to estimate and easy to interpret is at least partly offset by the likely misspecification of the model.

Structured additive distributional regression provides a generic framework for inference in regression models in which each parameter of a potentially complex response distribution and not only the mean is related to a structured additive predictor. We propose a unified Bayesian approach for multivariate structured additive distributional regression comprising a huge class of continuous, discrete and latent multivariate response distributions, where each parameter of these potentially complex distributions is modelled by a structured additive predictor. The latter is an additive composition of different types of covariate effects e.g. nonlinear effects of continuous covariates, random effects, spatial effects, or interaction effects. As a flexible approach for constructing tailor-made multivariate response distributions, we consider copula-based regression models since they enable the separation of the marginal response distributions and the dependence structure summarised in a specific copula model. Inference is realised by a generic, computationally efficient Markov chain Monte Carlo algorithm based on iteratively weighted least squares approximations and with multivariate Gaussian priors to enforce specific properties of functional effects. Applications to illustrate our approach include a joint model of risk factors for chronic and acute childhood malnutrition in India and ecological regression studying the drivers of election results in Germany.