Modular Regression - A Lego System for Building Structured Additive Distributional Regression Models with Tensor Product Interactions

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Semiparametric regression models offer considerable flexibility concerning the specification of additive regression predictors including effects as diverse as nonlinear effects of continuous covariates, spatial effects, random effects, or varying oefficients. Recently, such flexible model predictors have been combined with the possibility to go beyond pure mean-based analyses by specifying regression predictors on potentially all parameters of the response distribution in a distributional regression framework. In this talk, we introduce a generic concept for defining interaction effects in such semiparametric distributional regression models based on tensor products of main effects and illustrate this for spatio-temporal interactions as well as functional random effects. The interactions can be anisotropic, i.e. different amounts of smoothness will be associated with, e.g., spatial and temporal effects. We investigate identifiability and the decomposition of interactions into main effects and pure interaction effects (similar as in a smoothing spline analysis of variance) to facilitate a modular model building process. Inference is based on Markov chain Monte Carlo simulations with iteratively weighted least squares proposals under constraints to ensure identifiability and effect decomposition.