Additive Density-on-Scalar Regression in Bayes Hilbert Spaces with an Application to Gender Economics

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We present structured additive regression models to model densities given scalar covariates. To preserve nonnegativity and integration to one, we formulate our models for densities in a Bayes Hilbert space with respect to an arbitrary finite measure. This enables us to not only consider continuous densities, but also, e.g., discrete densities (compositional data) or mixed densities. Mixed densities occur in our application motivated by research on gender identity norms and the distribution of the woman's share in a couple's total labor income, as the woman's income share is a continuous variable having discrete point masses at zero and one for single-earner couples. We discuss interpretation of effect functions in our model via odds-ratios. We consider two data situations: First, where whole densities are observed and are directly used as responses. Second, when only individual scalar realizations of the conditional distributions are observed, we use our additive regression approach to model the conditional density given covariates. We derive consistency and asymptotic normality of the proposed Bayes space (penalized) maximum likelihood estimator. To facilitate estimation, we show approximate equivalence of the Bayes space (penalized) likelihood to the (penalized) likelihood of a certain Poisson additive model. We apply our framework to the motivating gender economic data from the German Socio-Economic Panel Study (SOEP) to analyze the distribution of the woman's share in a couple's total labor income, given year, place of residence and age of the youngest child.

About the Speaker:
Sonja Greven is a professor of Statistics at the Humboldt University of Berlin. Her research interests lie in the area of functional data analysis and biostatistics. She serves as the spokesperson of the DFG AI research unit "Fusing Deep Learning and Statistics towards Understanding Structured Biomedical Data". Prior to her appointment in Berlin, Sonja Greven was an associate professor of Biostatistics at the Department of Statistics at LMU Munich and she holds a PhD from LMU Munich.

References:
Maier, E., Stöcker, A., Fitzenberger, B., & Greven, S. (2024). Additive Density-on-Scalar Regression in Bayes Hilbert Spaces with an Application to Gender Economics. To appear in Annals of Applied Statistics.