Bayesian learning and forecasting of age-specific period mortality via locally adaptive spline processes

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Abstract:

While the analysis of mortality has a long and well-established history, the attempt to accurately learn and forecast changes in such process across ages and periods still attracts active research. State-of-the-art contributions rely either on parsimonious formulations which facilitate interpretable inference at the cost of reduced predictive accuracy, or consider flexible representations that improve the forecasting quality but affect interpretability. We address this trade-off via novel locally adaptive spline processes which are carefully constructed to incorporate the main structures of period mortality curves while allowing interpretable inference, accurate prediction and efficient computation within a single model. This is obtained by modeling age-specific mortality curves through spline functions with dynamic coefficients that capture changes across periods via nested Gaussian process priors having locally varying smoothness. Combining spline bases and nested Gaussian process priors yields high flexibility and allows interpretable inference on changes across periods in mortality patterns for different age profiles, while accounting for possible shocks. In addition, this formulation can be accurately approximated by a Gaussian state-space model which facilitates closed-form filtering, smoothing and forecasting, not only of the trends in the spline coefficients across periods, but also of the first derivates which measure rates of change in mortality for different age groups. The advantages of the proposed methods relative to state-of-the-art competitors are illustrated on Italian mortality data.

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