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Multi-Population Longevity Models: A Spatial Random Field Approach

January 2020

Multi-Population Longevity Models: A Spatial Random Field Approach

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Abstract

We investigate joint modeling of longevity trends using the spatial statistical framework of Gaussian Process regression. Our analysis is motivated by considering the Human Mortality Database that provides raw mortality tables for nearly 40 countries and clearly demonstrates the commonality in global longevity. Yet few stochastic models exist for handling more than two populations at a time. To bridge this gap, we develop a spatial covariance approach that treats mortality data through the lens of smoothing and forecasting noisy input-output relationships. In our framework, multiple populations are approached as distinct levels of a factor covariate, explicitly capturing the cross-population dependence. We demonstrate that our approach not only provides improved accuracy, but intrinsically generates coherent joint future longevity scenarios. It also offers an opportunity to borrow the most recently available data from other datasets, leading to more precise (and statistically more credible) forecasts regarding mortality improvement rates. All the numerical algorithms are implemented using R and Stan statistical languages and are publicly available. We illustrate using numerous figures on multiple European HMD datasets for both Males and Females

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