D4 A Multi-Factor Functional Approach to Mortality Forecasting

Arman Haqqi Anna Zili (PhD) Faculty of Design & Creative Technologies

Accurate forecasts of human lifespans matter enormously to pension funds and life insurers, as even small errors can lead to large financial shortfalls over decades. Current forecasting models often learn death rate patterns only once, projecting them forward, which means initial errors can quietly accumulate. My doctoral research develops a self-correcting forecasting approach that repeatedly examines and corrects what the current model gets wrong. Unlike existing step-by-step methods that fix one error at a time, my approach applies a sequence of small corrections, each capturing several dimensions of the remaining error simultaneously (Li et al., 2025). A further refinement keeps these corrections smooth across ages, making forecasts more believable, especially for older ages where pension obligations are largest. In this presentation, I will focus on one question: when does this self-correcting model improve forecasts? Using data from the Human Mortality Database for the USA, Japan, France, and the United Kingdom over 1969 to 2019, evaluated across thirteen expanding windows and ten horizons by sex, I will show that my self-correcting model helps precisely where simpler models leave systematic errors, and adds little where those models are already sufficient. I will also show that the smoothing refinement consistently improves accuracy, and that the forecast uncertainty ranges prove reliable. I will also address the caveat that no single model fits every country, and therefore providers should match their model's complexity to the population they serve.

Keywords
Mortality forecasting, functional time series, gradient boosting, weak learners, age regularisation, actuarial interpretability

References

Li, L., Li, H., & Panagiotelis, A. (2025). Boosting domain-specific models with shrinkage: An application in mortality forecasting. *International Journal of Forecasting, 41*(1), 191-207. https://doi.org/10.1016/j.ijforecast.2024.05.001