Dynamic Prediction of Non-Gaussian Functional Outcomes with Fast Generalized Functional Principal Components Analysis

Biomedical investigators are often interested in predicting future observations of subjects based on their historical data, referred to as dynamic prediction. Traditional methods are often limited in flexibility and computationally intensive, especially with non-Gaussian data. To address these issues, we propose a novel method for dynamic prediction based on Generalized Functional Principal Component Analysis (FPCA). Assume the observed outcome follows an exponential family distribution parameterized by a latent Gaussian function, the proposed method consists of the following steps: 1) Bin the data across functional domain into small, equal-length intervals; 2) Fit local generalized mixed models at every bin to estimate individual latent functions; 3) Fit FPCA model to smooth latent functions and 4) Obtain estimates of subject-specific PC scores using partial observations and recover the unobserved part on the binned grid. Our simulation study showed the proposed method achieved significantly better out-of-sample predictive performance compared to existing methods with much shorter computation time, thus has the potential to be widely applicable to large datasets.