In biomedical studies, investigators are often interested in predicting future or missing observations of subjects based on their historical data, referred to as dynamic prediction. Traditional methods (e.g., mixed models, joint modeling) are often limited in flexibility and computationally intensive, especially with dense non-Gaussian outcomes (e.g., binary and count data). To address these problems, we propose a novel method for dynamic prediction based on Generalized Functional Principal Component Analysis (FPCA) and Functional Mixed Models.

Assume the observed outcome follows a 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, non-overlapping intervals; 2) Fit local generalized mixed models at every bin to obtain estimated latent function for each subject; 3) Fit FPCA model on estimated latent functions. We can than obtain estimates of subject-specific PC scores based on partial observations, thus recover the unobserved, latent function on the binned grid. Our simulation study showed the proposed method achieved significantly better out-of-sample predictive performance compared to existing method with much shorter computation time, thus has the potential to be widely applicable to large datasets.