Assessing Systematic Effects of Stroke on Motor Control Using Hierarchical Function-on-Scalar Regression

**Abstract**

This work is concerned with understanding common population-level effects of stroke on motor control while accounting for possible subject-level idiosyncratic effects. Upper extremity motor control for each subject is assessed through repeated planar reaching motions from a central point to eight pre specified targets arranged on a circle. We observe the kinematic data for hand position as a bivariate function of time for each reach. Our goal is to estimate the bivariate function-on-scalar regression with subject-level random functional effects while accounting for potential correlation in residual curves; covariates of interest are severity of motor impairment and target number. We express fixed effects and random effects using penalized splines, and allow for residual correlation using a Wishart prior distribution. Parameters are jointly estimated in a Bayesian framework, and we implement a computationally efficient approximation algorithm using variational Bayes. Simulations indicate that the proposed method yields accurate estimation and inference, and application results suggest that the effect of stroke on motor control has a systematic component observed across subjects.