Classical Testing in Functional Linear Models

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We extend four tests common in classical regression -Wald, score, likelihood ratio and F tests - to functional linear regression, for testing the null hypothesis, that there is no association between a scalar response and a functional covariate. Using functional principal component analysis, we re-express the functional linear model as a standard linear model, where the effect of the functional covariate can be approximated by a finite linear combination of the functional principal component scores. In this setting, we consider application of the four traditional tests. The proposed testing procedures are investigated theoretically for densely observed functional covariates when the number of principal components diverges. Using the theoretical distribution of the tests under the alternative hypothesis, we develop a procedure for sample size calculation in the context of functional linear regression. The four tests are further compared numerically for both densely and sparsely observed noisy functional data in simulation experiments and using two real data applications.