Heterogeneous Individual Risk Modeling of Recurrent Events

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Abstract: Progression of chronic disease is often manifested by repeated occurrences of disease-related events over time. Delineating the heterogeneity in the risk of such recurrent events can provide valuable scientific insight for guiding customized disease management. In this paper, we present a new dynamic modeling framework, which renders a flexible and robust characterization of individual risk of recurrent event through quantile regression that accounts for both observed covariates and unobservable frailty. The proposed modeling requires no distributional specification of the unobservable frailty, while permitting the exploration of dynamic effects of the observed covariates. We develop estimation and inference procedures for the proposed model through a novel adaptation of the principle of conditional score. The asymptotic properties of the proposed estimator, including the uniform consistency and weak convergence, are established. Extensive simulation studies demonstrate satisfactory finite-sample performance of the proposed method. We illustrate the practical utility of the new method via an application to a diabetes clinical trial that explores the risk patterns of hypoglycemia in Type 2 diabetes patients.