

SEMIPARAMETRIC INFERENCE FOR FUNCTIONAL SURVIVAL MODELS

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Abstract: In recent years, there has been growing interest among researchers in modeling right-censored survival data with functional covariates. While existing functional methods primarily focus on the Cox model, its proportional hazards assumption can be challenging to verify and may be violated in practice. To address this issue, we extend the ordinary differential equation (ODE) framework for survival data to incorporate functional covariates and develop an inference procedure for both scalar and functional parameters. Specifically, we establish asymptotic normality and semiparametric efficiency for the scalar coefficient estimators, enabling a valid inference procedure. Additionally, we derive an asymptotic simultaneous confidence band for the functional parameter. Simulations are conducted to evaluate the finite sample performance of the proposed method.

Key words and phrases: Functional data analysis, right censored data, semiparametric information bound, sieve maximum likelihood estimator, transformation model.

1. Introduction

Survival data analysis plays a crucial role in various fields, such as biomedical science and reliability engineering, where it is used to investigate the time until a specific event occurs, such as patient death in clinical applications or component failure in industrial settings. One major challenge in analyzing survival data arises from censoring, which occurs when the exact event times are not fully observed. Such censored time data are commonly encountered in longitudinal or periodic follow-up studies, such as clinical trials. To address such challenge, various statistical methods have been developed, including semiparametric models (Cox, 1972; Kalbfleisch and Prentice, 2002; Zhong, Mueller and Wang, 2022) and nonparametric models (Kaplan and Meier, 1958; Aalen, 1978). Among these, the Cox proportional hazard model (Cox, 1972) is the most widely used and popular approach in survival analysis. For more details, we refer readers to monographs (Cox and Oakes, 1984; Fleming and Harrington, 1991).

Recently, Tang et al. (2022) introduces an ordinary differential equation (ODE) notion for survival data which unifies many existing survival models, where the cumulative function of event time T for some subject X , denoted as

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