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Simulation Study of Cumulative Hazard Estimators Under Nonparametric, Cox, and Gradient Boosting Frameworks

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Abstract

This thesis compares nonparametric and semi–parametric estimators of the cumulative hazard function through simulation studies, both with and without random right–censoring. Within the nonparametric framework, the Nelson–Aalen estimator is compared to a log transformation of the Kaplan–Meier estimator. In the Cox proportional hazards framework, the Breslow estimator with regression coefficients estimated by partial likelihood is compared to the Nelson–Aalen estimator with known coefficients, across unstratified and stratified models with varying covariate complexity. Finally, the Breslow estimator is evaluated with and without the assistance of a Gradient Boosting Machine estimating the log relative risk function, under both linear and nonlinear covariate structures. Performance is assessed using bias, integrated squared error and squared error at the last observed survival time, across a range of baseline hazard shapes. The results show that Nelson–Aalen and Kaplan–Meier perform comparably with Nelson–Aalen generally achieving lower integrated squared error, while the Breslow estimator dominates Nelson–Aalen as soon as multiple covariates are present. The Gradient Boosting Machine improves the Breslow estimator, especially under nonlinear covariate structures where the Cox model is unsuitable, while offering moderate improvement under linear structures.

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