Survival Model Based Time-dependent Receiver Operating Characteristic Curves and Predictive Accuracy

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Abstract

The ROC (receiver operating characteristic) curve methodology is currently a well-developed statistical tool to evaluate the ability of biomarkers to discriminate the case (disease) and control (non-disease) of patients. Recent research has been focused on incorporating time-dependency to ROC framework to gain efficiency and to do dynamic prediction. To connect with survival model, the time-dependent ROC curves for the Cox model with fixed covariates has been derived not only for dynamic prediction but also for the model evaluation based on the average time-dependent AUC (the area under the ROC curves), which is proven to be a concordance summary measure for predictive accuracy. However, the Cox regression model needs a proportional hazards assumption which may fail in some of the medical studies. In such situation, we develop an approach to replace the Cox model by the accelerated failure time (AFT) model to derive time-dependent sensitivity and specificity. Moreover, we further extend the developing approach to the Cox model and the AFT model with longitudinal covariates. Since the average time-dependent AUC is a concordance measure, for prediction purpose, we may select a better model between the Cox or the AFT model by choosing a model with higher predictive accuracy. When the longitudinal covariates are subject to measurement errors or do not have complete covariate history, an imputation method through joint model is used to correct the bias of estimates. Simulation studies will be conducted to evaluate the performance of proposed approach. A case study of Taiwanese HIV cohort data will be used to illustrate the usefulness of the proposed model-base time-dependent AUC and predictive accuracy.

Keywords: AFT model, Cox model, joint model, time-dependent AUC