Abstract:
The most popular model used for survival analysis is the proportional hazards regression model proposed by Cox. This is mainly due to its exceptional simplicity. Nevertheless the fundamental assumption of the Cox model is the proportionality of the hazards. For many applications, however, this assumption is doubtful. Proposals to extend the Cox model for non-proportional hazards to allow for dynamic effect structures usually either depend on prespecifications or require non-standard estimation techniques and are thus not favoured in application. Moreover, tests to verify the dynamic effect structures are not straightforward or lack omnibus power. In this paper we propose a flexible method for modelling dynamic effects in survival data within the Cox framework. The method is based on fractional polynomials as introduced by Royston and Altman. This allows for a transformation of the dynamic predictor which leads back to the conventional Cox model and hence fitting is straightforward using standard estimation techniques. In addition, it offers the possibility of easily verifying the existence of time-variation. We describe a model selection algorithm which selects time-varying effects only when evidence is given in the data. We illustrate the properties of the approach in a simulation study and compare it with other methods. In a survival study of gastric cancer patients, we apply the approach to analyse dynamic structures in the effects of prognostic factors.