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Recurrent Neural Networks for Complex Survival Models

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Abstract : Survival analysis has become one of the paramount procedures in the modeling of time-to-event data. When we encounter complex survival problems, the traditional approach remains limited in accounting for the complex correlational structure between the covariates and the outcome due to the strong assumptions that limit the inference and prediction ability of the resulting models. Several studies exist on the deep learning approach to survival modeling; moreover, the application for the case of complex survival problems still needs to be improved. In addition, the existing models need to address the data structure's complexity fully and are subject to noise and redundant information. In this study, we design a deep learning technique (CmpXRnnSurv_AE) that obliterates the limitations imposed by traditional approaches and addresses the above issues to jointly predict the risk-specific probabilities and survival function for recurrent events with competing risks. We introduce the component termed Risks Information Weights (RIW) as an attention mechanism to compute the weighted cumulative incidence function (WCIF) and an external auto-encoder (ExternalAE) as a feature selector to extract complex characteristics among the set of covariates responsible for the cause-specific events. We train our model using synthetic and real data sets and employ the appropriate metrics for complex survival models for evaluation. As benchmarks, we selected both traditional and machine learning models and our model demonstrates better performance across all datasets.

Keywords : cumulative incidence function (CIF), risk information weight (RIW), autoencoders (AE), survival analysis, recurrent events with competing risks, recurrent neural networks (RNN), long short-term memory (LSTM), self-attention, multilayers perceptrons (MLPs)
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