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Education for Statistics in Practice

Dynamic prediction in survival analysis

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Extended abstract

This course will focus on methodology for dynamic prediction. The dynamic aspect of dynamic prediction involves using information on events and/or measurements up to the present, in order to "update" the prediction. It will be shown in this course how dynamic predictions may be obtained using the concept of landmarking. Analyses will be illustrated using R, in particular the **dynpred** package. Implementation of the methods in other statistical software packages like SAS, Stata and SPSS will be discussed.
Participants are expected to have a fair knowledge of the techniques from classical survival analysis.

Dynamic prediction

The medical literature abounds with prediction models. They are statistical models based on patient- and disease characteristics, used to inform treatment decisions, to provide personalized risk estimates for the patient, and also to stratify patients in clinical trials. Important prognostic models include Adjuvant! Online in cancer and the Framingham risk score in cardiovascular disease. The vast majority of these models are focused on prognosis at one well-defined baseline moment, typically at diagnosis, shortly before treatment is initiated. It is at this time that the most important decisions on primary treatment are made. There is little doubt that the available prognostic models are important tools for the treating physician to guide treatment decisions at diagnosis. However, once primary treatment has been initiated, the prognosis of the patient will change over the course of time, as a result of the effect of treatment, possible treatment toxicity, and clinical events such as disease recurrence that may have occurred, and, very simply, because of the fact that the patient is still alive. As a result, these prediction models need to be "updated" to use the knowledge that has become available since baseline. Prediction models that incorporate this dynamic aspect are called dynamic prediction models, and they are the topic of this course.

Dynamic use of familiar survival analysis techniques

A short overview of survival analysis will be given, including the Cox model. The emphasis in this overview will be on how these familiar techniques can be used to obtain dynamic predictions. We will introduce conditional survival (the effect of being alive) and the fixed width failure function, and their relation to the familiar hazard function. Extensions to competing risks will briefly be mentioned.

Time-dependent covariates and landmarking

We will then introduce time-dependent covariates and discuss techniques to handle them such as time-dependent Cox regression and landmarking. The differences between these approaches and the relative merits will be discussed.

Landmarking and dynamic prediction

Then we will show how landmarking can be used to include time-dependent information in the dynamic predictions. We will briefly discuss more traditional methods that can also be used for dynamic prediction, such as multi-state models. Advantages and disadvantages of different approaches will be discussed.

Practical implementation

Methods discussed during the lectures will be illustrated using R, and in particular the **dynpred** package. Data used is available from the presenter upon request.

About the presenter

Hein Putter is Professor at the Leiden University Medical Center (Department of Biomedical Data Sciences). His research interests include competing risks and multi-state models, frailty models and dynamic prediction. He is co-author of the book “Dynamic Prediction in Clinical Survival Analysis”, with Hans van Houwelingen

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