Dynamic and Individualized Prediction of Cardiovascular Events: The International Childhood Cardiovascular Cohort (i3C) Consortium

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ABSTRACT

Our recent study has shown that cardiovascular risk factors of body-mass index, systolic blood pressure, total cholesterol level, triglyceride level and smoking beginning in early childhood, were associated with adult cardiovascular events and death from cardiovascular causes. In this article, we developed three joint models to predict the individual risk of CVD based on individual subject's demographic information and their CVD risk factors measured over time: 1) constant-coefficient joint model (CCJM), 2) varying coefficient joint model (VCJM), and P-spline joint model (mvJM-Spline). All three models have clinically useful results with AUC values of 0.84, 0.85, and 0.92, respectively. An R Shiny webtool was developed to implement the dynamic risk prediction tool.

Keywords: dynamic prediction, individualized prediction, cardiovascular disease

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OPERA: An Interpretable Algorithm for Patient Stratification based on Partially Ordered Risk Factors

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ABSTRACT

Risk stratification is an invaluable tool for modern healthcare systems. By separating patients into subgroups with distinct disease severity and prognosis, it allows better clinical decision making due to targeted care thus ultimately fosters healthier patient populations. In addition, it enhances communication, engagement, and research focus. This talk presents a new algorithm entitled 'Ordering Poset Elements by Recursive Amalgamation' (OPERA) for patient stratification using many risk factors. Health risk factors frequently exhibit total or partial ordering and when considered jointly, they form a partially ordered set or a poset. Compared with the usual regression models, OPERA can explore high order interactions similar to the well-known tree method. On the other hand, by explicitly exploring the poset structure, OPERA allows flexible and interpretable staging patterns and faster pruning for better performance. OPERA is evaluated in extensive simulation studies and cancer staging data to demonstrate its ability in performing risk stratification using ordered risk factors.

Keywords: Cancer staging, partial order, regression tree, risk stratification

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α-Separability and Adjustable Combination of Amplitude and Phase Model for Functional Data

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ABSTRACT

We consider separating and joint modelling amplitude and phase variations for functional data in an identifiable manner. To rigorously address this separability issue, we introduce the notion of α-separability upon constructing a family of α-indexed metrics. We bridge α-separability with the uniqueness of Fréchet mean, leading to the proposed adjustable combination of amplitude and phase model. The parameter α allows user-defined modelling emphasis between vertical and horizontal features and provides a novel viewpoint on the identifiability issue. We prove the consistency of sample Fréchet mean and variance, and proposed estimators. Our method is illustrated in simulations and COVID-19 infection rate data.

Keywords: Fréchet mean; functional data analysis; identifiability; joint model; separability; variation decomposition

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