THE UNIVERSITY OF CHICAGO

Department of Statistics

DISSERTATION PRESENTATION AND DEFENSE

WALTER DEMPSEY

Department of Statistics
The University of Chicago

Statistical Methods in Joint Modeling of Longitudinal and Survival Data

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ABSTRACT

Survival studies often generate not only a survival time for each patient but also a sequence of health measurements at annual or semi-annual check-ups while the patient remains alive. Such a sequence of random length accompanied by a survival time is called a survival process. Ordinarily robust health is associated with longer survival, so the two parts of a survival process cannot be assumed independent. The first part of the thesis is concerned with a general technique—reverse alignment—for constructing statistical models for survival processes. A revival model is a regression model in the sense that it incorporates covariate and treatment effects into both the distribution of survival times and the joint distribution of health outcomes. The revival model also determines a conditional survival distribution given the observed history, which describes how the subsequent survival distribution is determined by the observed progression of health outcomes.

The second part of the thesis explores the concept of a consistent exchangeable survival process - a joint distribution of survival times in which the risk set evolves as a continuous-time Markov process with homogeneous transition rates. A correspondence with the de Finetti approach of constructing an exchangeable survival process by generating iid survival times conditional on a completely independent hazard measure is shown. Several specific processes are detailed, showing how the number of blocks of tied failure times grows asymptotically with the number of individuals in each case. In particular, we show that the set of Markov survival processes with weakly continuous predictive distributions can be characterized by a two-dimensional family called the harmonic process. The outlined methods are then applied to data, showing how they can be easily extended to handle censoring and inhomogeneity among patients.

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