Transformations of Continuous-Time Dynamic Models into Alternative Discrete-Time Models: Why, How, and Implications on Causality Inference

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Irregularly spaced longitudinal data often arise in experience sampling studies that use partially random sampling intervals to capture the participants' status in the moment. Many structural equation modeling (SEM) approaches for fitting longitudinal or dynamic models to intensive longitudinal data treat the time intervals between successive occasions as equally spaced (e.g., in computing lagged covariance or correlation matrices for model fitting purposes) and are not well suited for use with irregularly spaced data. Several authors have introduced continuous-time models in the form of linear stochastic differential equation (SDE) models as a way to accommodate such irregularly spaced time intervals, and discussed their parallels with the SEM framework. Unfortunately, the relations between SDEs and their discrete time counterparts, such as vector autoregression (VAR) and structural VAR (SVAR) models adopted broadly in dynamic network analyses, are not well understood, leading at times to misconceptions of these alternative formulations as completely distinct modeling options. In this talk, we present and discuss the relations and transformation functions for mapping linear SDE models to VAR and SVAR, and implications on causality inference. Code and demonstrations for fitting these models to irregularly spaced data using an R package, dynr, are provided, followed by discussions of some of the caveats, challenges, and possible extensions to leverage these transformations to fit continuous-time dynamic network models.

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