Joint analysis of multiple longitudinal and survival data measured on nested time-scales: an application to predicting infertility

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Abstract: "Fertility-tracker apps are now widely used by couples attempting to get pregnant. Thus, providing a rich source of data that are large in magnitude compared to the more traditional scientifically designed pregnancy studies. Motivated by these rich data sources, we aim to build models for predictions of individual time-to-pregnancy based on joint models of underlying biology and behavior of couples. We will first discuss the joint modeling of longitudinal binary data (ie, intercourse pattern of couples), highly skewed longitudinal process (ie, menstrual cycle lengths, proxy for her reproductive health) and a discrete survival time (ie, time-to-pregnancy).

The intercourse observations are a long series of binary data with a periodic probability of success and the amount of available intercourse data is a function of both the menstrual cycle length and TTP. Moreover, these variables are dependent and observed on different, and nested, time scales (TTP measured in months, length of each menstrual cycle in months while intercourse measured on days within a menstrual cycle) further complicating its analysis. Here, we propose a semi-parametric shared parameter model for the joint modeling of the binary longitudinal data (intercourse behavior), skewed continuous longitudinal process (menstrual cycle) using a mixture distribution and the discrete survival outcome (TTP). Finally, we develop couple-based dynamic predictions to assess the risk for infertility. We will discuss computational methods used to make the model fitting fast as well as talk about how our approach can be used to model data collected from app-based fertility trackers.

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