Model-Based Data Analysis: Detecting and Resolving Non-identifiability

When a mathematical model is confronted with data, many sensitive parameters can not be estimated directly from the data and need to be estimated indirectly through model fitting. One of the main challenges in model fitting is the non-identifiability issue: infinitely many parameter values can produce the same quality fit. This may not sound like a serious issue since we can use any of these values. However, if the goal of modeling is to estimate quantities that are not observable, then it is very often the case that two different parameter values with the same model fit to data can produce drastically different estimations on unobservable quantities. It is essential to detect and resolve non-identifiability when performing model fitting.

After introducing different notions of non-identifiability, I will review some existing methods for detecting and ranking non-identifiable parameters. I will introduce a new method using singular value decomposition and variance decomposition, which has several advantages over existing methods. I will then use model-based HIV estimation as an example to illustrate the issues and their solutions.