

State-Space Models for Identifying Abrupt Changes in Cognitive Development

Thursday 24 July 2025 15:30 (15 minutes)

State-space models (SSMs) provide a powerful framework for modeling dynamic systems, capturing both intra-individual and inter-individual variability in longitudinal data. In the context of cognitive development research, one interesting feature of SSMs is their ability to model deviations, or “shocks,” in individual trajectories. Such shocks may signal atypical changes that could be considered outliers within developmental processes. In this study, we adapt a semi-exploratory procedure proposed by You et al. (2020) to the context of cognitive development, using the dynr package (Ou et al., 2019) in R.

Our main objectives are to: a) propose a novel SSM designed to detect outliers in developmental trajectories; and b) evaluate its performance in terms of accuracy of outlier detection and recovery of the population parameters.

To evaluate these objectives, we performed an extensive Monte Carlo study. First, we generated data based on empirical trajectories. We manipulated several simulation conditions, including sample size, number of time points per participant, timing of shocks, and proportion of participants affected by shocks. Next, we examined the impact of these factors on group-level parameter bias, and the balanced accuracy of the individual outliers identification. Based on our findings, we discuss the utility of SSMs to detect abrupt environmental changes affecting cognitive development.

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Session Classification: Symposium : “Advancing Dynamic Methods for Modeling Change Over Time”

Track Classification: Statistical analyses: Statistical analyses