Multilevel Structure Modeling of Wearable Device Data with Applications in Population Studies

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Abstract: With the recent development and popularity of wearable devices, actigraphy has been widely used in large-scale population studies to provide continuous and objective activity measures and monitor daily sleep-activity patterns. While actigraphy contains rich information, statistical methods to effectively extract and analyze the information are still lacking. How to effectively analyze time-series physical activity data collected for one week, one month or even longer is challenging and how to account for multilevel structures due to data collection procedures is also crucial for estimating covariate effects. In this talk, I will discuss our proposed method for analyzing actigraphy in population studies. To achieve dimension reduction, we applied functional principal component analysis to characterize main activity patterns. To account for the cluster structure due to multistage sampling as well as the multilevel structure due to within-individual observations across time, we used mixed effects models to capture the multilevel information, estimate group effects, and delineate individual activity profiles. Implementation of our methods in an actigraph dataset from middle school students provides novel insights into adolescent activity patterns. We are able to characterize the heterogeneity in daily activity patterns, estimate covariate effects and further identify the association between physical activity and mental health.