The latent factor structure of child development

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Abstract

Hello

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Introduction

A child's development can be thought of as the set of developmental milestones that they have reached at a particular point in time. This conceptualization results in data with the same structure as the item response data common to educational measurement. In education, item response data is most typically students responding to test items (i.e., questions) and, in the dichotomous case, getting each question either correct or incorrect. In the context of child development, the child is the "student," and each developmental milestone is the "item."

We use Kinedu, a Mexico-based child development app, as a source for this type of data. When parents first start using the Kinedu app, they are asked a series of questions about which developmental milestones their child has reached. We consider the 1946 children between 2 and 55 months of age whose parents responded to all 414 of the developmental milestones. Each developmental miletone on Kinedu is mapped to a milestone group: physical, cognitive, linguistic, or social & emotional. Table 1 shows the number of developmental milestones in each group along with an example milestone in Spanish (as its shown to the parent) and its translation in English.

Figure 1 shows the age (in months) and number of developmental milestones for each child. As can be seen in Figure 1, at 12 months of age, most children have reached about 200 developmental milestones. At 24 months of age, most children have reached about 300 developmental milestones. Finally, at 48 months of age, most children have reached about 375 of the 414 developmental milestones.

Empirical assessment of the dimensionality of child development

We frame the assessment of the dimensionality of child development as a model comparison question.

Models

Item response theory offers a suite of models with which to model item response data. We adopt the notation used in Chalmers & others (2012). Let $i = 1, \ldots, I$ represent the distinct children and $j = 1, \ldots, J$ the developmental milestones. The Kinedu item response data is stored in a matrix, y, where element y_{ij} denotes if the ith child has or has not achieved the jth developmental milestone as reported by their parent/guardian. Each model represents the ith child's development using m latent factors $\boldsymbol{\theta}_i = (\theta_1, \ldots, \theta_m)$. The jth milestone's discriminations (i.e. slopes) $\boldsymbol{\alpha}_j = (\alpha_1, \ldots, \alpha_m)$ capture the latent factor loadings onto that milestone.

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References

Chalmers, R. P., & others. (2012). Mirt: A multidimensional item response theory package for the r environment. *Journal of Statistical Software*, *48*(6), 1–29.