Specifying an AR model at level-1 for unequally spaced measurements

The option to specify a model with first-order auto-regressive level-1 random errors and random intercepts and/or slopes at level-2 is available in HLM. However, it is assumed that data were collected according to a fixed design (see following section for more on fixed design).

For example, T observations were collected for participant A at the same time as for participant B, that is $X_j = X \forall j$. Regressors X_j having varying designs may be included in the model, but coefficients associated with such values must not have random effects at level-2. Note that this means that level-1 predictors having random effects in HMLM and HMLM2 must have the same value for all participants at a given occasion. If they do not have the same value, these predictors can only be specified as fixed effects. If random effects are selected for inclusion in the model, the program will automatically reset these to have fixed effects only at level-2.

In some studies, for example where data were collected for all respondents repeatedly at different time points, the time of measurement for respondents will not be the same. For example, data may have been collected 3 times per day for each respondent over 3 days, but the actual time of measurements may differ from respondent to respondent. For each respondent, there is a maximum of 9 measurements, which correspond to a maximum of 9 x (the number of respondents) unique times of measurement. In this type of data, sequential observations may be more strongly related than observations separated by a longer period of time and it may be useful to incorporate this information into the model. In terms of the HLM model, this cannot currently be incorporated into the error structure.

However, the information from measurement may be used as a predictor in the form

$$Y_i(measure) = Y_{i-1}(measure) + r$$

where Y_{i-1} represents the previous measurement for a given subject.

In order to incorporate the amount of time elapsed between measurements, a variable with the elapsed time between each pair of measurements for each respondent can be created. This variable can then be used as predictor of the outcome studied in combination with the use of the AR option in HLM.

Another option would be to treat the time points as equally spaced and to add the actual times of measurement as a predictor in the analysis. In doing so, the results of different approaches to this problem can be compared.