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## Online appendix: Running the Stat-JR cross-classified mixed-effects location scale model template

In this appendix we provide a short overview on how to specify and estimate the cross-classified mixed-effects location scale model presented in this article in the Stat-JR software.

The Stat-JR software is developed by the Centre for Multilevel Modelling at the University of Bristol, UK. A comprehensive introduction to the software is provided in Browne (2013). A free 30-day trial version of the software can be downloaded from the Stat-JR website along with many additional resources <http://www.bristol.ac.uk/cmm/software/statjr>.

In this appendix, we use Stat-JR's point-and-click interface (Stat-JR-TREE) as this is the most accessible interface for those new to the software. However, we recommend that Stat-JR users move over to the Stat-JR's command interface once they are familiar with the software.

In order to follow this appendix readers should first download, install and launch the Stat-JR-TREE interface. They should then use the Dataset and Template drop-down menus to upload both the example dataset and the cross-classified mixed-effects location scale template provided with this appendix. Model setup and estimation then proceeds as follows.

### Step 1. Specification of the location-scale fixed effects

First, the data structure must be specified (fig. 1). Interviewer clustering is specified as 'Higher level classification 1' and area clustering is specified as 'Higher level classification 2'. We also specify the response variable (`getalong_neigh`) and any covariates in the location model (equation 2).

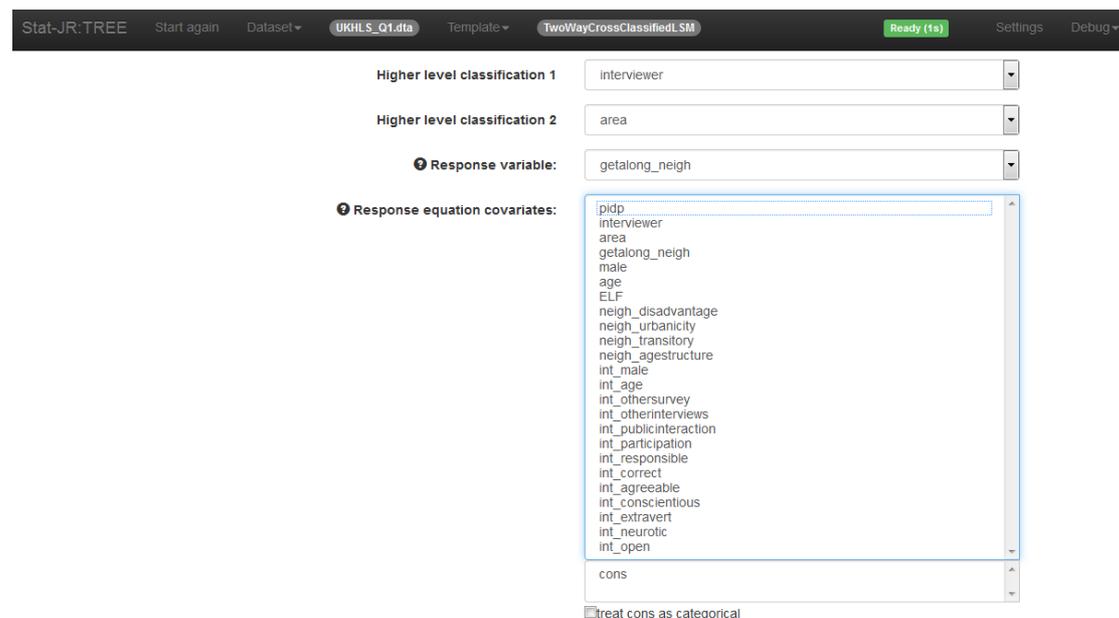


Fig. 1. Stat-jr window

Any covariates included in the scale model (equation 3) can then be specified (fig. 2). Having specified the fixed part of the model press ‘Next’ to continue.

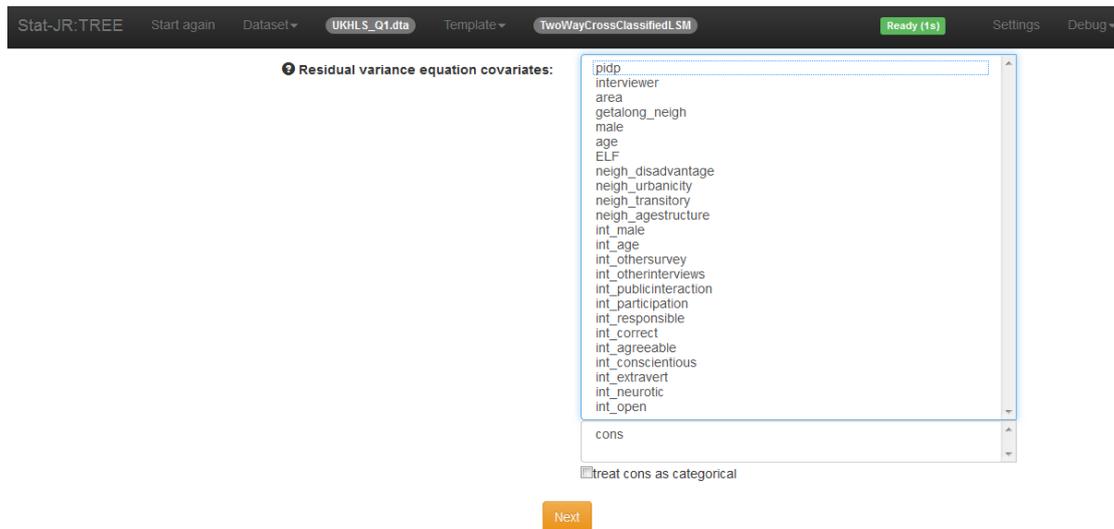


Fig. 2. Stat-jr window (continued)

### Step 2. Specification of the scale random effects

Stat-JR will then ask whether you wish to include interviewer and area random-intercepts in the residual variance function (fig. 3). We select yes to include the interviewer random-intercept  $u_j^{[2]}$  from equation 3 in the model. We do not include an area level random-intercept in the residual variance, but this specification is possible. Press ‘Next’ to continue.

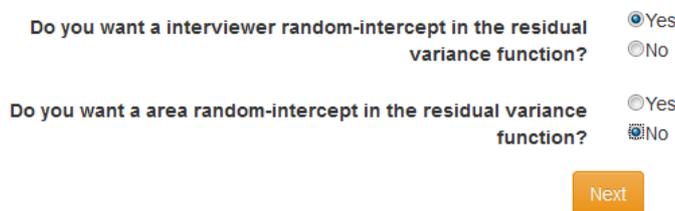


Fig. 3. Scale equation specification

### Step 3. Selecting priors for the random effects

It is then necessary to specify priors for the interviewer random effects covariance matrix (equation 4). It is possible to include Uniform or Wishart priors (fig. 4). Press ‘Next’ to continue. Stat-JR will then ask if you wish to store the random effects. These can be used for the calculation of the interviewer-specific ICCs (equation 6). Press ‘Next’ to continue.

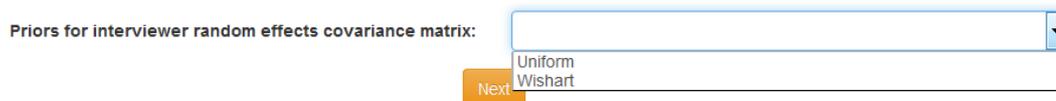


Fig. 4. Priors for the random effects covariance matrix

### Step 4. Specification of the MCMC chains

The number of MCMC chains to be run, length of burn-in to discard and chain monitoring length can then be specified (fig. 5). For particularly long MCMC chains, or chains that exhibit a high degree of dependency, it is also possible to specify a thinning factor to only save some iterations. We retain the default algorithm settings, however it is also possible to adjust the number of adapting iterations, acceptance rate, and adapting tolerance for the MCMC chains (recommended for advanced users only). Press 'Next' to continue.

The screenshot shows a configuration interface for MCMC chains. It includes several input fields and a radio button group. The fields are: 'Number of chains' with a dropdown menu set to 3; 'Random Seed' with a text input field containing 1; 'Length of burnin' with a dropdown menu set to 5000; 'Number of iterations' with a dropdown menu set to 10000; and 'Thinning' with a dropdown menu set to 1. Below these fields is a radio button group for 'Use default algorithm settings' with 'Yes' selected. An orange 'Next' button is positioned at the bottom of the form.

Fig. 5. MCMC chains

### Step 5. Additional options

It is also possible to generate a prediction dataset for additional analysis post-estimation (fig. 6). Advanced users can also choose to specify their own starting values for all parameter estimates, however for most users the default option will be optimal. Press 'Next' to continue.

The screenshot shows a configuration interface for additional options. It includes two radio button groups. The first group is for 'Generate prediction dataset' with 'No' selected. The second group is for 'Use default starting values' with 'Yes' selected. An orange 'Next' button is positioned at the bottom of the form.

Fig. 6. Additional specification options.

### Step 6. Naming results

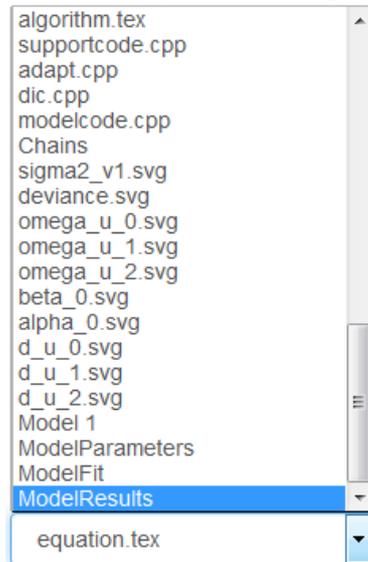
Finally, it is necessary to name the output. Press 'Next' to continue. Then press 'Run'. The status bar at the top of Stat-JR will turn blue and the estimation engine will begin to cycle through the MCMC iterations. When estimation has completed, the status bar will turn green and the number of seconds the model took to run will be displayed.

The screenshot shows a configuration interface for naming the model. It includes a text input field for 'Name of output results' containing 'Model 1'. An orange 'Next' button is positioned below the input field.

Fig. 7. Naming the model

### Step 7. Examining model results

When the model has finished running, we recommend that you save all results for subsequent analysis. This can be achieved by pressing ‘Download’. It is also possible to examine all model results and a range of diagnostics by selecting the drop down box currently labelled ‘equation.tex’ (fig. 8).



*Fig. 8. Viewing model output*

To examine specific MCMC chains, select the appropriate .svg files. For example, to examine the chain associated with the variance of the interviewer scale effect  $\sigma_{u[2]}^2$  (equation 4) we select ‘omega\_u\_2.svg’ (fig. 9).

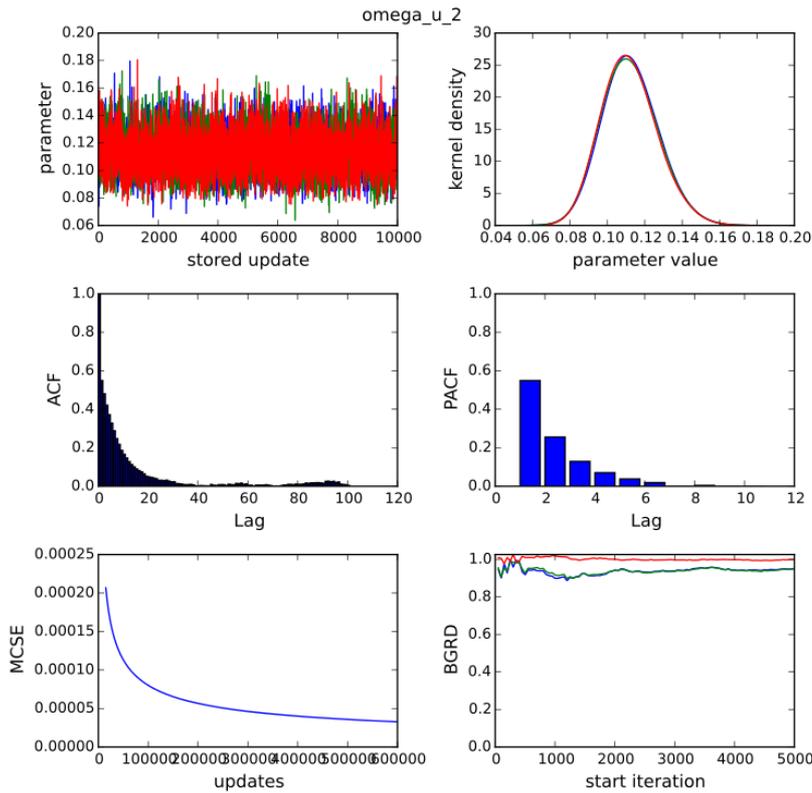


Fig. 9. MCMC diagnostics

To see the full list of model parameters and the DIC, select ‘ModelResults’ (fig. 10).

Results				
Parameters:				
parameter	mean	sd	ESS	variable
sigma2_v1	0.0555404490734	0.00411488920313	1803	
deviance	36435.0234425	91.8881970201	3565	
omega_u_0	0.0237048340415	0.00316010675305	5018	
omega_u_1	0.0363707374841	0.00509964226726	6193	
omega_u_2	0.112026049188	0.0136672031273	3514	
beta_0	1.27682285622	0.0119469461146	1885	cons
alpha_0	-0.753880643212	0.023481853294	838	cons
d_u_0	87.7213344087	15.5914840552	3438	
d_u_1	-28.6455367807	6.2849473462	3158	
d_u_2	18.5263944076	3.23638283142	2728	
Model:				
Statistic	Value			
Dbar	36435.0234425			
D(thetabar)	35040.6632737			
pD	1394.36016887			
DIC	37829.3836114			

Fig. 10. Full model output

It is also possible to use the full range of Stat-JR post-estimation options once model estimation has completed. For full details, see (Browne et al., 2013).

## References

Browne, W. J., Charlton, C. M. J., Michaelides, D. T., Parker, R. M. A., Cameron, B., Szmaragd, C., Yang, H., Zhang, Z., Goldstein, H., Jones, K., Leckie, G., Moreau, L (2013) *A Beginner's Guide to Stat-JR's TREE interface version 1.0.0*. Centre for Multilevel Modelling, University of Bristol & Electronics and Computer Science, University of Southampton.