Scheibehenne, Rieskamp, & Wagenmakers:
Testing Adaptive Toolbox Models: A Bayesian Hierarchical Approach

Online Supplement
Overview of the Computer Code

This folder contains all BUGS code and the corresponding R code to conduct the model comparisons and to plot the figures used in the paper by Scheibehenne, Rieskamp, & Wagenmakers (Testing Adaptive Toolbox Models: A Bayesian Hierarchical Approach).

Running the code requires:

a) Background knowledge in the R and BUGS programming language
b) A computer that has R and WinBUGS properly installed.

For scholars new to Bayesian Data Analysis using BUGS, we recommend an introductory classbook like "Doing Bayesian Data Analysis" by John K. Kruschke (Academic Press) or the "Course in Bayesian Graphical Modeling for Cognitive Science" by E.J. Wagenmakers and Michael Lee.

The code was tested on Windows XP using WinBUGS but other samplers like JAGS should also work.

General Remarks

One analysis per folder

The files are ordered according to the chapters in the paper. For each analysis, all required files are in the respective folders (see below for details).

Starting point

Within each folder, there is one R-file that has the name *start* in its title. This file provides the starting point for the respective analyses.

Change working directory

Make sure to set the working directory to the folder that contains the *start* function by changing the variable *workingDir* inside in the *start* function.

BUGS models

Within each folder, the code for the BUGS models is stored in.*txt* files and can be viewed or edited with any conventional text editor. There are commonly two BUGS files in each folder: One to estimate the models separately (to obtain pseudopriors) and one to estimate the Bayes Factor.

Chain length

For faster (but less precise) results, the length of the Markov chains can be reduced. For most models, the number is currently set to 4 chains that contain a net total of 100,000 samples after each chain has been thinned-out by a factor 10 and a burn-in of 6,000 samples.

BUGS parameters

The length of the Markov chains, the number of chains, the amount of thinning, and the used sampler (default = WinBUGS) can be changed in the R-file starting with *estimate*... See the comment on top in the start file in R for details. If you want to set the debug parameter in WinBUGS to TRUE, you can do so in the *runBUGS.r* file.

Path to WinBUGS

The default path to WinBUGS is set to: "C:/Program Files/WinBUGS14". If you install WinBUGS into another folder (not recommended), you need to change this in the file *runBUGS.r* that is available in each folder.

Results

The resulting plots are saved in the respective *Plots* folder. Coda objects of the obtained Markov Chains are saved in the *Results* folder.

Chainplots and Convergence

Chainplots, full posterior distributions of the estimated parameters, and plots displaying the Gelman-Rubin shrink factor are either displayed on the screen or, if available, saved in the folders *Chainplots* and *Gelmanplots*.

Overview of the Files

Analyses on the Individual Level

Individual Simulation

Analysis of simulated choice data on the individual level. Here, the proportion of using WADD and TTB and the individual application error is systematically varied.

- Starting function: *startIndividualSimulation.r*

- BUGS model to estimate model parameters: *TBvsSingleStrategy_individual_BUGS.txt*
- BUGS model to compare models using pseudopriors: *TBvsSingleStrategy_individual_pseudo_BUGS.txt*

Analzye RieskampOtto Individual

Analysis of the choice data from the experiment by Rieskamp, J., & Otto, P. E. (2006). SSL: A theory of how people learn to select strategies*. Journal of Experimental Psychology: General*, 135, 207-236. Here, a toolbox consisting of two tools, Take-the-best (TTB) and Weighted-Additive (WADD) is compared against a single model (either TTB *or* WADD) for each individual decision maker in the experiment. The underlying BUGS model is the same as in the *Individual Simulation*.

- Starting function: *startAnalysisIndividual.r*

- BUGS model to estimate model parameters: *TBvsSingleStrategy_individual_BUGS.txt*
- BUGS model to compare models using pseudopriors: *TBvsSingleStrategy_individual_pseudo_BUGS.txt*

- Original data, made available by the original authors are in the folder *RieskampOtto_Data*

Analyze JansenVdMaas2002

Analyzes balance scale data from the paper: Jansen, B. R. J. & van der Maas, H. L. J. (2002). The Development of Children's Rule Use on the Balance Scale Task. *Journal of Experimental Child Psychology*, 81, 383-416.

- Starting Function: *startAnalysisJansenVdMaas2002.r*

- BUGS model to compare Rule 1 against a toolbox R1&R2: *TB12_R1.txt*
- BUGS model to compare Rule 2 against a toolbox R2&R3: *TB23_R2.txt*
- BUGS model to compare Rule 3 against a toolbox R2&R3: TB23_R3.txt

- Original data, kindly made available by the original authors: rawDataJansenVdMaas2002.csv

Analyze LewandowskyKalishNgang2002

Analyzes function learning data from Lewandowsky, S., Kalish, M. & Ngang, S. K. (2002). Simplified Learning in Complex Situations: Knowledge Partitioning in Function Learning. *Journal of Experimental Psychology: General*, 131, 163-193.

- Starting function for "linear" experts (results presented in the paper): *startAnalysisLewandowsky2002_linear.r*
- BUGS model to estimate model parameters: *bothModelsRegressionBUGS2tauZellner_linear.txt*
- BUGS model to compare models: *mixtureModelRegressionBUGSPseudoprior2tauZellner_linear.txt*

- *Starting function for "quadratic"* experts (results briefly mentioned in the paper): *startAnalysisLewandowsky2002_quadratic.r*
- BUGS model to estimate model parameters: *bothModelsRegressionBUGS2tauZellner_quadratic.txt*
- BUGS model to compare models: *mixtureModelRegressionBUGSPseudoprior2tauZellner_quadratic.txt*

- Original data, kindly made available by the original authors: *rawDataLewandowsky2002.csv*

Analyze YangLewandowsky2004

Analyzes category learning data from Yang, L. X. & Lewandowsky, S. (2004).Knowledge Partitioning in Categorization: Constraints on Exemplar Models. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 30, 1045-1064.

- Starting function: *startAnalysisYangLewandowsky2004.r*

- BUGS model to estimate model parameters: *BUGSModelYangBothModels.txt*
- BUGS model to compare models using pseudopriors: *BUGSModelYangPseudoprior.txt*
- BUGS model to compare models without pseudopriors (not used): *BUGSModelYangModelindex.txt*

- Original data, kindly made available by the original authors are in the folder *Rawdata*

Analyze RieskampOtto Individual TB3

Analysis of the choice data from the experiment by Rieskamp, J., & Otto, P. E. (2006). SSL: A theory of how people learn to select strategies*. Journal of Experimental Psychology: General*, 135, 207-236. Here, a toolbox consisting of two tools, Take-the-best (TTB) and Weighted-Additive (WADD) is compared against a toolbox consisting of three tools (TTB, WADD, and TALLY) for each individual decision maker in the experiment.

- Starting function: *startAnalysisIndividualTB3_TB2.r*
- BUGS model to estimate model parameters: *ToolboxBin3.and.TB2.txt*

Analyze RieskampOtto Individual Exemplar

Analysis of the choice data from the experiment by Rieskamp, J., & Otto, P. E. (2006). SSL: A theory of how people learn to select strategies*. Journal of Experimental Psychology: General*, 135, 207-236. Here, a toolbox consisting of Take-the-best (TTB) and Weighted-Additive (WADD) is compared against an Exemplar model of choice for each individual decision maker in the experiment.

- Starting function: *startAnalysisIndividualExemplar.r*

- BUGS model to estimate model parameters: *Exemplar_TB_single.txt*
- BUGS model to compare models using pseudopriors: *Exemplar_TB_single_Pseudo.txt*

Analyses on the group level

Grouplevel Simulation

Analysis of simulated choice data on the group-level. Here, the proportion of individual decision makers in a group who use either WADD or TTB and the individual application error is systematically varied.

- Starting function: *startGroupSimulation.r*

- BUGS model to estimate model parameters: *ToolboxBinomialModelindexGroup.txt*
- BUGS model to compare models using pseudopriors: *ToolboxBinomialPseudoGroup.txt*

Analyze RieskampOtto Grouplevel

Hierarchical group-level analysis of the choice data from the experiment by Rieskamp, J., & Otto, P. E. (2006). SSL: A theory of how people learn to select strategies. *Journal of Experimental Psychology: General*, 135, 207-236. Here, a toolbox consisting of Take-the-best (TTB) and Weighted-Additive (WADD) is compared against a single model on the group level. The underlying BUGS model is the same as in the *Grouplevel Simulation*.

- Starting function: *startAnalysisGrouplevel.r*

- BUGS model to estimate model parameters: *ToolboxBinomialModelindexGroup.txt*
- BUGS model to compare models using pseudopriors: *ToolboxBinomialPseudoGroup.txt*

Analyze RieskampOtto Grouplevel Exemplar

Hierarchical group-level analysis of the choice data from the experiment by Rieskamp, J., & Otto, P. E. (2006). SSL: A theory of how people learn to select strategies. *Journal of Experimental Psychology: General*, 135, 207-236. Here, a toolbox consisting of Take-the-best (TTB) and Weighted-Additive (WADD) is compared against an Exemplar model of choice on the group level.

- Starting function: *startAnalysisRieskampExemplarGroup.r*

- BUGS model to estimate model parameters: *ExemplarGroupModelindex.txt*
- BUGS model to compare models using pseudopriors: *ExemplarPseudoHierarchical.group.txt*

Comparison of BUGS against BIC

Systematic comparison between Bayes Factors approximated by BIC against BUGS estimates.

- Starting function for the case of dependent error terms: *startBICvsBFcomparison.2errors.r*
- Starting function for the case of different beta priors: *startBICvsBFcomparison.betaPrior.r*

- BUGS model for independent error terms: *TB12_R1_independentError.txt*
- BUGS model for dependent error terms: *TB12_R1_dependentError.txt*
- BUGS model to allow for different beta priors: *TB12_betaPrior.txt*