Resources for Multilevel Modeling

Following is an extensive list of various types of resources related to multilevel modeling including websites, books, journal articles, software and related training, guide provides a set of resources to those who are interested in learning more about multilevel modeling. The guide is intended for those at all levels. Many of these materials were obtained from the Web and the URLs are given in those instances.

WEBSITES

1. Judith Singer (Ph.D., Statistics, Harvard University) is the James Bryant Conant Professor of Education and former Academic Dean at the Harvard Graduate School of Education. One of the nation's leading applied statisticians, her professional life focuses on improving the quantitative methods used in social, educational and behavioral research. Singer is primarily known for her contributions to the practice of multilevel modeling, survival analysis, and individual growth modeling, and to making these and other statistical methods accessible to empirical researchers.
   http://gseweb.harvard.edu/~faculty/singer/

2. Centre for Multilevel Modeling, University of Bristol
   http://www.mlwin.com/

3. Software Reviews of Multilevel Analysis Packages
   http://www.mlwin.com/softrev/index.html

4. Are Multilevel Techniques Necessary? An overview, including Simulation Studies Ita G.G. Kreft, California State University, Los Angeles, June 25, 1996
   http://www.calstatela.edu/faculty/ikreft/quarterly/quarterly.html

5. The Public Health Disparities Geocoding Project Monograph
   http://www.hsph.harvard.edu/thegeocodingproject/webpage/monograph/multilevel.htm

6. The UCLA Academic Technology Services who maintain data and worked examples in a number of different software packages for a number of different multilevel textbooks
   www.ats.ucla.edu/stat/examples/

BOOKS

1. Luke DA. Multilevel Modeling: Quantitative Applications in the Social Sciences. July 2004 Sage Publications Inc.

2. Snijders T., Bosker R. Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling 1999. Sage Publications Inc.

3.	Kreft I.G., Leeuw Jd. Introducing Multilevel Modeling Jan. 1998. Sage Publications Inc.

4.	Heck R.H., Thomas S.L. An Introduction to Multilevel Modeling Techniques. Dec. 1999 Lawrence Erlbaum Associates.

5.	Reise S.P., Duan N. Multilevel Modeling: Methodological Advances, Issues and Applications Jan. 2003. Lawrence Erlbaum Associates.

6.	Raudenbush, S. W., and A. S. Bryk.. Heirarchical linear models: Applications and data analysis methods. 2002 Thousand Oaks, CA: Sage.

JOURNAL ARTICLES

1.	Messer LC, Laraia BA, Kaufman JS, Eyster J, Holzman C, Culhane J, Elo I, Burke JG, O'Campo P. The development of a standardized neighborhood deprivation index. J Urban Health. 2006 Nov;83(6):1041-62.

SOFTWARE
 (The information in this section was obtained from the Centre for Multilevel Modeling website http://www.mlwin.com/links/materials.shtml)

If you want to see how a particular model can be fitted in particular software, there are resources in development at UCLA:
www.ats.ucla.edu/stat/examples/

For those wishing to analyze longitudinal data, software instructions in a wide range of programs is provided by UCLA to accompany the textbook Singer JD, Willett JB, 2003 *Applied longitudinal data analysis: modeling change and event occurrence*, New York, Oxford University Press, at:
www.ats.ucla.edu/stat/examples/alda/

Training associated with software

A growing amount of web-based (or at least downloadable) training materials are being developed. We have organized this section by the particular software that is being used, and rather arbitrarily separated commercial software from the freeware that follows.

Software	Training Material Description
aML	Can be used to fit a range of multilevel models but has specific features for fitting multi-process or simultaneous equation models to hierarchical data where predictor variables may be non-random or

endogenous, and other types of models used by economists such as a multilevel Heckman selection models
www.applied-ml.com/product/multiprocess.html

HLM	The official site gives guidance at www.ssicentral.com/hlm/examples.html There is very good introductory material on how to set up the models by Information Technology Services at the University of Texas Jason Newsom's Multilevel Regression course that uses HLM, but covers a lot of other ground too (eg Distinguishing between random and fixed: variables, effects, and coefficients; comparison of estimators, and kinks to SPSS Mixed)
MLwiN	You can download a version of the software, data and training manuals from TRAMMS (Teaching Resources and Materials for Social Scientists) The manuals are a course in themselves The substantial enhancement of the MCMC procedures in *MLwiN* is discussed in full in *MCMC Estimation in MLwiN* (pdf) which is to be used with the version 2.0 of the program
Mplus	This software allows structural equation modeling, multilevel modelling and mixture modelling; their web site, www.statmodel.com has training downloads and examples.
SAS	Judy Singer has a pdf download that shows how to fit multilevel models in PROC MIXED; it is very well written. UCLA has implemented the Singer example in other software (eg R\Splus, HLM, *MlwiN*, SPSS) www.ats.ucla.edu/stat/paperexamples/singer/default.htm C.J. Anderson has a lot of material for his course online at www.ed.uiuc.edu/courses/EdPsy490CK/ Data and SAS related material are available for Applied Longitudinal Analysis by Garrett Fitzmaurice, Nan Laird, James Ware at biosun1.harvard.edu/~fitzmaur/ala/ The code and data to fit the models contained in SAS System for Mixed Models (1996) by RC Littell, GA Milliken, WW Stroup, and RD Wolfinger, is to be found at http://ftp.sas.com/samples/A55235

SPSS   A useful discussion of the Linear Mixed Models procedure in SPSS Advanced Models is to be found at http://www.spss.com/downloads/Papers.cfm (search for Linear mixed-effects modeling in SPSS)

also an HTML downloadable tutorial based on a set of case studies

John Painter provides a clear guide on how to fit multilevel models using SPPS mixed
www.unc.edu/~painter/

Another brief demonstration of SPSS Mixed in action is to be found at
step.psy.cmu.edu/materials/spss/mixed.doc (word doc)

Freeware

There are a number of programs that are available at low or nil cost; some of these are general (like R), others are more specific but can have special features that make them particularly attractive; we have tried to identify these special features below. We have also pointed to some appropriate training resources.

Software	Description
BAYESX	has a number of distinctive features including handling structured (correlated) and/or unstructured (uncorrelated) effects of spatial covariates (geographical data) and unstructured random effects of unordered group indicators. It allows non-parametric relationships between the response and the predictors (generalized additive models) and does this for continuous and discrete outcomes, it can manipulate and display geographical maps www.stat.uni-muenchen.de/~lang/bayesx/bayesx.html
BUGS	**B**ayesian inference **U**sing **G**ibbs **S**ampling is really a flexible language that allows the fitting of a very wide range of models using MCMC methods; this is a very rich site developed by the MRC Biostatistics Research Unit in Cambridge which has lots of freely downloadable software and detailed manuals www.mrc-bsu.cam.ac.uk/bugs A number of courses using BUGS have been put online, a listing is given at www.mrc-bsu.cam.ac.uk/bugs/weblinks/webresource.shtml Peter Congdon has written two books based around BUGS (Bayesian Statistical Modelling, and Applied Bayesian Modelling) data and programmes are available for both books at in zipped form, downloadable

from

ftp://www.wiley.co.uk/pub/books/congdon/

GeoBUGS	is an add-on to BUGS that has been developed by a team at Imperial College to fit spatial models and produce a range of maps as output www.mrc-bsu.cam.ac.uk/bugs/winbugs/geobugs.shtml
GLLAMM	this software usefully undertakes multilevel latent class and factor analysis, adapative quadrature to derive the full likelihood with discrete and normal response, and has facilities for fitting non-parametric models in which the distribution at the higher level can be non-normal (you need STATA to run this software; preferably STATA 8); this software is particularly useful for the models listed above, but can be slow to converge. This site is also a rich one with growing number of downloads of lectures and papers showing how the approach can be used in practice www.gllamm.org/
MIX	These are a set of stand-alone programs that fit a number of specific models including mixed-effects linear regression, mixed-effects logistic regression for nominal or ordinal outcomes, mixed-effects probit regression for ordinal outcomes, mixed-effects Poisson regression, and mixed-effects grouped-time survival analysis. They have a common interface, and importantly they calculate the likelihood directly so allowing comparison of the change in deviance for nested models. The are versions for Windows as well as for PowerMac and Solaris www.uic.edu/~hedeker/mix.html
R	is complete system for statistical computation and graphics, it can be seen as an Open Source implementation of the S language which in turn underlies the S-Plus software. It is distributed freely under the GNU General Public License and can be used for commercial purposes. It operates across a very wide range of platforms. The latest version and documentation can be obtained via CRAN, the Comprehensive R Archive Network cran.r-project.org/
R/S	Normal-theory models are fitted in R using lme and nlme functions described in full in 'Mixed-effects models in S and S-PLUS&lsquo by J. C. Pinheiro and D. M. Bates (2000), there is an additional support for this book at cm.bell-labs.com/cm/ms/departments/sia/project/nlme/ for discrete responses there is the function glmmPQL which is discussed in the 4th edition of Modern applied statistics with S W. N. Venables and B. D. Ripley; the book also covers normal theory models; there is online support for the book at

www.stats.ox.ac.uk/pub/MASS4/

Jeff Gill maintains a website that provides help, tutorials and references for those who want to use R
psblade.ucdavis.edu/

Useful macros and other software

Software	Description
PreML	There is a very useful utility written so as to export an SPSS file into a MLwiN worksheet, it is down-loadable from Tom Snijders' webpage http://stat.gamma.rug.nl/snijders/PreML.inc
Diagnostics	Tom Snijders' homepage contains a set of MLwiN macros for producing diagnostics and for fitting a social network model stat.gamma.rug.nl/snijders/mlnmac.htm
PINT	For determining appropriate required sample sizes and power in a two-level model; there is a manual
OD	is another program for power analysis and optimal design, it has excellent graphical output, you will need to read the published papers by Steve Raudenbush and Xiao-Feng Liu sitemaker.umich.edu/group-based a manual has now appeared at Steve Raudenbush's personal website
DismapWin	is a public domain software for the statistical analysis of epidemiological maps; it allows the analysis of unobserved heterogeneity using mixture models; the program offers a Poisson regression approach which links disease and exposure data www.medizin.fu-berlin.de/sozmed/DismapWin.html
PROC TRAJ	is a SAS® procedure, written by Bob Jones, that fits a discrete mixture model to longitudinal data, and thereby implements Nagel's group trajectory model; a very useful site for this type of model with downloads of papers is www.andrew.cmu.edu/user/bjones/

COURSES ON MULTILEVEL MODELING

The multilevel website maintains a list of courses using MLwiN
http://www.mlwin.com/support/workshop.html

The Michigan-based Summer Program in Quantitative Methods of Social Research usually has one or more courses
http://www.icpsr.umich.edu/training/summer/

There is a two-week long course by Kelvyn Jones and Myles Gould consisting of 10 half-days at The Essex Summer School
http://www.essex.ac.uk/methods/

On a two year basis there is a week-long course by Kelvyn Jones and Subramanian at the Swiss Summer School (based in Lugano)
http://www.unige.ch/ses/sococ/ss/

There is a unit at Brussels in December taught by Kelvyn Jones
http://www.kubrussel.ac.be/english/index.htm

Lemma will be providing introductory and advanced training on a regular basis
http://www.ncrm.ac.uk/nodes/lemma/training.php