

GLMM

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Package comparison

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Packages

For now, this page is only covering "basic" mixed modeling packages (although the line is admittedly somewhat blurry): see the [list of packages on the main page](#) for packages covering additive mixed models, Cox regression, etc.

In a nutshell

R packages

MCMCglmm. Uses MCMC instead of ML to fit the model. Bayesian priors can be included. Some complex variance structures (heterogeneous yes, AR1 no).

nlme One of the first widely-used mixed-models software for S-Plus. Ported from S-plus to R. Nested random effects easily modeled. Crossed random effects difficult. Stable (maintenance-mode). Multiple functions (lme for linear, nlme for nonlinear, gls for no random terms). Complex (and custom) variance structures possible. No GLMMs.

lme4. Under active development, especially for GLMMs. No complex variance structures. Uses sparse matrix algebra, handles crossed random effects well. Much faster than nlme.

glmmADMB interface to ADMB (see below); flexible, but slower than other R packages.

non-R

ADMB. Automatic Differentiation Model Builder. Mostly used in Forestry/Fish/Wildlife. Started out as a commercial product, but now open-source. Non-linear models handled. ADMB-RE, implements random effects in non-linear models via Laplace, importance sampling, GHQ in some cases.

SAS Commercial. Full-featured.

PROC MIXED implements modern LMMs; it is very widely used with lots of examples, but can be very slow.

PROC GLIMMIX added generalized models; it now incorporates Laplace approximation and adaptive Gaussian quadrature, but falls back to PQL for models with complex correlation structures. It also has other features such as simpler syntax to request predictable functions of random effects.

HEMIXED is "High Performance" to address the slow speed of MIXED, but low-featured.

PROC NLMIXED is for non-linear and linear models (i.e. models that cannot be fitted in PROC MIXED/GLIMMIX, such as those with unusual variance-covariance structures or variances that are functions of fixed or random predictors). It also fits GLMMs via Laplace/GHQ (but "not" crossed effects). Multiple denominator degrees of freedom methods (Kenward Roger, Satterthwaite, Containment).

ASREML Commercial: free licenses available for academic and developing-country use. Available as a standalone, R package (ASREML-R, or in Genstat. Uses sparse matrices and Average Information for speed. Widely used in plant and animal breeding. Numerous error structures supported. Splines well-integrated. Generalized models: PQL only, warnings in documentation. Wald-type tests. Constraints on parameters allowed.

(To add: npmlreg, regress (from Gabor Grothendieck))

Linear mixed models

Generalized linear mixed models

Nonlinear mixed models and other extensions

Interfaces from R to other systems

Accessor methods within R

Linear mixed models

package	function	estimation	inference (tests)	inference (confidence intervals)	random effects (G str
nlme	lme	ML, REML	Wald (summary), likelihood ratio test (anova), sequential and marginal conditional F tests (anova)	Wald intervals on fixed and RE parameters (intervals)	multiple (nested) rando effects; diagonal, blocked struc (pdClasses); crossed possible, but sl
lme4	lmer ¹ ML, REML	ML, REML	F statistics (sans denominator df: summary), likelihood ratio test (anova), post-hoc MCMC (mcmcsmamp) ²	post-hoc MCMC mcmcsmamp	nested and crossed RE, Σ diagonal or block diago
				as above + likelihood	

http://glmm.wikidot.com/pkg-comparison

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Package comparison - GLMM

lme4a	lmer ⁴	as above	as above	profiles, fast parametric bootstrapping bootMer	as above
lmm	ecmestl.lmm	ML(ECME algorithm)			
lmm	fastml.lmm	ML(rapidly Converging algorithm)			
asreml	asreml	Sparse matrix, Average Information REML	Wald anova	Standard errors	Multiple crossed/nested/blocked
statmod	mixedModel2 ⁵	REML			
SAS	PROC MIXED	REML, ML, MIVQUE0, or Type1–Type3(method= option)	wald t and F test		multiple, complex (you can define the co-variance structure by type option random statement)
SAS	PROC GLIMMIX	pseudo likelihood(default), Laplace, GHQ, REML, PQL	Wald, LRT(COVTEST Statement), Type III test for fixed effects	Wald (default), LRT	Multiple, nested or crossed
SAS	HPMIXED	REML	wald t, F test, type III test and chisq test	wald intervals on fixed effect and random effect (CL option)	multiple, complex
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HLM	HLM	REML, FML			Multilevel, nested and crossed random effects
MLwiN		ML, MCMC			Multilevel, nested/crossed random effects
Stata?	xtmixed//xtreg(random-intercept model)	REML, ML	Wald, LR test (with ML)	Wald	multilevel, nested/crossed types of covariance structure, diagonal-blocked structures, Heteroskedastic random effects

GLMMs

package	function	estimation	inference (tests)	inference (confidence intervals)	family
lme4	glmer	Laplace, AGHQ	Wald (summary), LRT (anova), simulation tests of simple random effects (RLRsim package)	Wald (by hand)	Poisson, binomial
lme4a	glmer	Laplace, AGHQ	Wald (summary), LRT (anova)	Wald (by hand): eventually, likelihood profiles	Poisson, binomial
glmmML	glmmML	Laplace, AGHQ	Wald		Poisson, binomial [logit, probit]
glmmAK	logpoissonRE	MCMC	Wald		Poisson
MCMCglmm	MCMCglmm	MCMC	'Bayesian p-value'	credible intervals (coda::HPDinterval)	Gaussian, Poisson, categorical, multinomial, exponential, various zero-inflated
MASS	glmmPQL	PQL	Wald (summary)	Wald	binomial, Poisson, Gamma (see ?family)
gamlss.mx	glmmNP	GHQ/Expectation-maximization			many (see gamlss.family package)
glmmBUGS	glmmBUGS	MCMC			Poisson, Binomial
hglm	hglm or hglm2	hierarchical likelihood	Wald (summary)		see ?family
HGLMMM	HGLMfit	hierarchical likelihood first order Laplace ?	Wald (summary) LRT (HGLMLRTTest())		Binomial(logit), poisson(log, inverse)
bernor	bnlogl	Monte Carlo sampling			Bernoulli (logit link)
glmmADMB	glmm.admb	Laplace	Wald (summary), LRT (anova), MCMC		Poisson, negative binomial, zero-inflation)
repeated	glmm	GHQ	Wald (summary)	Wald (by hand)	see ?family
R-INLA	inla	nested Laplace			Poisson, Binomial [logit, probit], Negative Binomial ...
SAS PROC GLIMMIX	PROC GLIMMIX	pseudo likelihood(default), Laplace, GHQ, REML, PQL	Wald, LRT(COVTEST Statement) Type III test for fixed effects	Wald (default), LRT	Binomial, Poisson, Gamma (option)
SAS PROC NLMIXED	PROC NLMIXED	GHQ, First-order method...(Check "method=" option) Laplace (QPOINTS=1 option)	Wald, LRT	Wald	Normal, Binomial, Poisson, Negative Binomial, Generalized (defined), zero-inflated

NLMMs and other extensions

package	function	estimation	inference (tests)	inference (confidence intervals)	families	random effects	other
nlme	nlme	ML OR REML	Wald t (summary) Wald F (anova)	use intervals()	no specific family required ?	nested	
lme4	nlmer	Laplace or PQL (method option)	wald (summary)	wald (hand?)	no family required	nested or crossed	

Accessors

		lme (nlme)	glmmPQL (MASS)	[g]lmer (lme4)	[g]lmer (lme4a)	MCMCglmm	glmm.admb
summary		estimate, std err, t, df, p	estimate, std err, t, df, p	lmer: estimate, std err, t glmer: est, std err, Z, p (Wald/asymptotic)	like lme4	post.mean, CI, eff.sample	estimate, std.error, z values, p
coef	all coefficients (predicted values for each group)	✓	✓	✓	✓	✓	✓
fixef	fixed effect parameters (β)	✓	✓	✓	✓		✓
ranef	random effect estimates (u)	✓	✓	✓	✓		✓
logLik	(marginal) log-likelihood	✓	✓	✓	✓		✓
AIC	marginal AIC	✓	✓	✓	✓		✓
confint	confidence intervals	✓	✓				✓
intervals	confidence intervals	✓	✓				
plot	diagnostic plots		✓			✓ (not diagnostic plots)	✓
predict	predicted values, allowing new data	✓	✓	✓		✓	✓
simulate	simulated values from fitted model	✓		✓	✓ (for lmer)		✓
fitted	fitted values	✓	✓	✓	✓	✓	✓
update	update model	✓	✓	✓	✓		✓
residuals		✓	✓	✓			✓
VarCorr	variance-covariance matrices of random effects	✓	✓	✓	✓		✓
coefplot	plot of coefficients and confidence/credible intervals	✓	✓	✓			✓
anova		✓		✓		✓ (no p-values)	✓ (compare two models)
drop1			✓ (no LRT)	✓		✓ (no p-values)	

Footnotes

1. faster than nlme but currently more limited 'model space'
2. for models with intercept variation in RE groups only
3. grouped RE terms assumed to be general positive diagonal; (block) diagonality achieved by separating grouping terms (e.g., $(1|g) + (0+x1+x2|g)$)
4. development version of lme4
5. This function is equivalent to 'lme(fixed=formula, random=~1|random)', except that the block variance component is not constrained to be non-negative, but is faster and more accurate for small to moderate size data sets. It is slower than 'lme' when the number of observations is large. (P) This function tends to be fast and reliable, compared to competitor functions which fit randomized block models, when then number of observations is small, say no more than 200. However it becomes quadratically slow as the number of observations increases because of the need to do two eigenvalue decompositions of order nearly equal to the number of observations. So it is a good choice when fitting large numbers of small data sets, but not a good choice for fitting large data sets.

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