Dr Simon Diffey, Biometrician, NSW Department of Primary Industries,

Authors: *Simon Diffey, Alan Welsh, Brian Cullis*

Title: A faster and computationally more efficient specification of a REML-(PX)EM algorithm for linear mixed models.

Abstract: Linear mixed models are routinely applied to data arising from designed experiments in animal and plant science. The statistical software packages ASReml and GenStat use a modified second-order algorithm which is computationally efficient known as the Average Information (AI) algorithm. However, unlike the (PX)EM algorithm the AI algorithm does not have monotonic convergence and parameter updates can be outside their parameter space. Often the AI algorithm fails to converge when fitting linear mixed models with complex variance structures. The factor analytic linear mixed model routinely applied to multi-environment trial (MET) data produced by plant breeding programmes is one such example where the AI algorithm often fails. Currently, in ASReml and GenStat there are a number of modifications to the original AI algorithm scheme presented by Gilmour et. al. 1995 to overcome some of these difficulties.

An alternative algorithm for fitting the linear mixed model is the (PX)EM algorithm. The (PX)EM algorithm although considerably slower than the AI algorithm has monotonic convergence and parameter updates remain in their parameter space. We present a new specification of a REML (PX)EM algorithm that is faster and computationally more efficient than previously published specifications. The REML (PX)EM algorithm we present has an incomplete data specification based on the Verbyla 1990 conditional derivation of REML.

We present some examples where we compare the REML (PX)EM algorithm based on this new specification of the incomplete data with previously published specifications of the REML (PX)EM algorithm.

References
Verbyla, A.P. (1990). *A conditional derivation of residual maximum likelihood*. Aust.J. Statist. **32**, 221-224.

Gilmour, A.R., Thompson, R., and Cullis, B.R. (1995). *Average Information REML: An Efficient Algorithm for Variance Parameter Estimation in Linear Mixed Models*, *Biometrics*, **51**(4),1440-1450.

Presenter Profile:
Simon Diffey has been a consulting biometrician in the areas of animal and plant science with the NSW Department of Primary Industries since 2002. He is nearing completion of a PhD programme through the Australian National University under the supervision of Professor Alan Welsh. His PhD considers new specifications of the (PX)EM algorithm for the REML estimation of variance parameters associated with linear mixed models with complex variance structures (factor analytic linear mixed models in particular) that are faster and computationally more efficient than previous specifications.