An Overview of Estimation Procedures for Generalized Linear Mixed Models

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Abstract
The Generalized Linear Mixed Model (GLMM) is a natural extension and mixture of a Linear Mixed Model and a Generalized Linear Model. The conditional mean of the response given the random effect(s) is linked to the linear predictor. The linear predictor comprises of fixed effects and random effects. The basic considerations or assumptions to construct a GLMM are (i) What is the distribution of the response? (ii) What is the distribution of the random effects? (iii) What kind of link is feasible between the conditional mean and the linear predictor? The model parameters can be estimated in closed form only for some very specific situations, like normal-normal, beta-binomial or gamma-poisson mixtures. But in other mixtures, especially when the number of nested random effects are more than two or the random effects are crossed, the closed form solutions are not possible or they are very complicated or tedious to obtain. In such situations, some approximation procedures are currently in practice. Penalized Quasi-Likelihood by Breslow, N. E. (2003), Expectation Maximization (EM) algorithm by Dempster, A. P. et al. (1977), Monte Carlo EM, Simulated Maximum Likelihood and Monte Carlo Newton Raphson by McCulloch, C. E. (1997) and Stochastic Approximation EM by Jank, W. (2006) are mostly used estimation procedures. The main features of these procedures will be highlighted and also an application of the techniques to a real data problem will be discussed.

References

Breslow, N. E. (2003). Whither PQL? [Biostatistics Working Paper Series, University of Washington]. (192).

Dempster, A. P., Laird, N.M., & Rubin, D.B. (1977). Maximum Likelihood from Incomplete Data via the EM Algorithm. *Journal of the Royal Statistical Society, Series B*, *39*(1), 1–38.

Jank, W. (2006). Implementing and Diagnosing the Stochastic Approximation EM Algorithm. *Journal of Computational and Graphical Statistics*, *15*(4), 1–27.

McCulloch, C. E. (1997). Maximum Likelihood Algorithms for Generalized Linear Mixed Models. *Journal of the American Statistical Association*, *92*(437), 162–170.