Mixed Model Equations:

$$\begin{bmatrix} X^T R^{-1} X & X^T R^{-1} Z \\ Z^T R^{-1} X & Z^T R^{-1} Z + G^{-1} \end{bmatrix} \begin{bmatrix} \hat{\beta} \\ \hat{u} \end{bmatrix} = \begin{bmatrix} X^T R^{-1} y \\ Z^T R^{-1} y \end{bmatrix}$$

solve for $\hat{\beta}$ and $\hat{u}$ $\Rightarrow$ equivalent to above solutions

In MME R^{-1} a much simpler structure. We assume residuals are uncorrelated, i.e. $cov(e_i, e_j) = 0$ and $var(e_i) = \sigma_e^2$ $\Rightarrow$ $R = I \cdot \sigma_e^2$

$\Rightarrow$ $R^{-1} = I \cdot \sigma_e^{-2}$

I: Identity matrix

$$\Rightarrow \begin{bmatrix} X^T X & X^T Z \\ Z^T X & Z^T Z + G^{-1} \cdot \sigma_e^2 \end{bmatrix} \begin{bmatrix} \hat{\beta} \\ \hat{u} \end{bmatrix} = \begin{bmatrix} X^T y \\ Z^T y \end{bmatrix}$$

* Obtained from data directly

Sire Model: is a LMM with sire effects as random model terms.

$$y = X\beta + Zs + e$$

s: sire effects, genetic contribution of a sire to an observation in an offspring (introduced in dairy cattle)