For a LME, also the definition of the expected values and the variance-covariance matrices are important.

- Expected values:

$$E(\underline{u}) = \underline{\emptyset} = E\begin{bmatrix} u_1 \\ u_2 \\ \vdots \\ u_K \end{bmatrix} = \begin{bmatrix} \emptyset \\ \emptyset \\ \vdots \\ \emptyset \end{bmatrix}$$

$$E(\underline{e}) = E\begin{bmatrix} e_1 \\ e_2 \\ \vdots \\ e_N \end{bmatrix} = \begin{bmatrix} \emptyset \\ \emptyset \\ \vdots \\ \emptyset \end{bmatrix} = \underline{\emptyset}$$

$$E(y) = E[X\beta + Zu + e] = E[X\beta] + E[Zu] + E[e]$$

$$= E[X\beta] + Z \cdot \underbrace{E[\underline{u}]}_{=\emptyset} + \underbrace{E[e]}_{\emptyset}$$

$$= X E[\beta] = X\beta$$

Variances: $\underbrace{var(\underline{u})}_{\text{Variance-covariance Matrix}} = G = \begin{bmatrix} var(u_1) & cov(u_1, u_2) \cdots \\ cov(u_2, u_1) & var(u_2) \cdots \end{bmatrix}$

$$var(\underline{e}) = R$$

Covariance between u and e:

$$cov(u, e^T) = \begin{bmatrix} cov(u_1, e_1) & cov(u_1, e_2) \cdots \\ cov(u_2, e_1) & cov(u_2, e_2) \cdots \end{bmatrix}$$