Notation: $Y = (Y_1, Y_2, \ldots, Y_n)^T \in \mathbb{R}^N$ and $U = (U_1, U_2, \ldots, U_q)^T \in \mathbb{R}^q$ are random vectors (response and random/mixed effects); $\beta \in \mathbb{R}^p$ is the vector of fixed effects; $X \in \mathbb{R}^{n \times p}$ and $Z \in \mathbb{R}^{n \times q}$ are model matrices, where x_i^T or z_i^T denote the ith row of X or Z respectively.