# Recap 2023-12-01

- Prediction of breeding values using BLUP-animal model
- BLUP animal model: Linear mixed effects model (LME)

$$y = X\beta + Zu + e \quad ; \text{ with } \beta: \text{fixed effects}$$

$u$: breeding values
$y$: response variable or observations
$e$: residuals

- BLUE - estimates $\hat{\beta}$ for fixed effects $\beta$
  BLUP - predictions $\hat{u}$ for breeding values $u$
- Mixed model equations:

$$\underbrace{\begin{bmatrix} X^TX & X^TZ \\ Z^TX & Z^TZ + \lambda A^{-1} \end{bmatrix}}_{M} \begin{bmatrix} \hat{\beta} \\ \hat{u} \end{bmatrix} = \begin{bmatrix} X^Ty \\ Z^Ty \end{bmatrix} \quad ; \quad \lambda = \frac{\sigma_e^2}{\sigma_u^2}$$

$$M \cdot \hat{s} = r$$

$A^{-1}$: inverse numerator relationship matrix

$$\hat{s} = \begin{bmatrix} \hat{\beta} \\ \hat{u} \end{bmatrix} = M^{-1} \cdot r \Rightarrow \text{solve}(M, r) \text{ in R}$$