

How Genomic BLUP Works

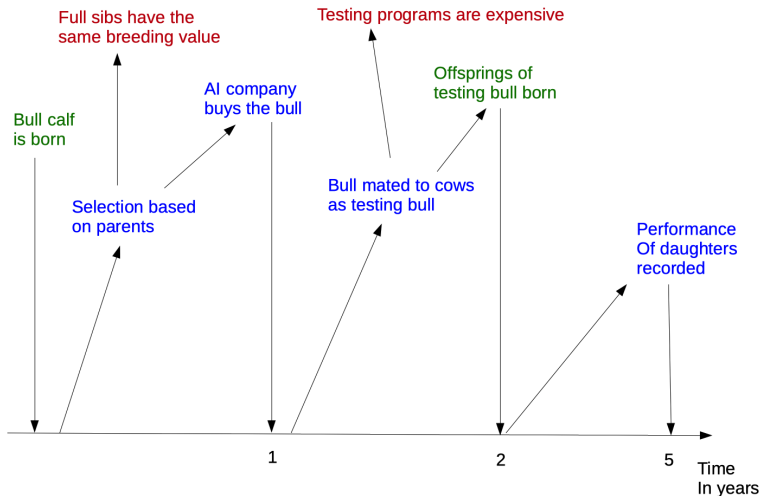
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Advantage of Genomic Selection

- ▶ Big advantage of genomic selection: **shorter generation interval**
- ▶ Old days: selection mainly based on performance tested sires
 - ▶ fine in species where generation interval is low, e.g. pigs
 - ▶ problem when generation interval is long like cattle

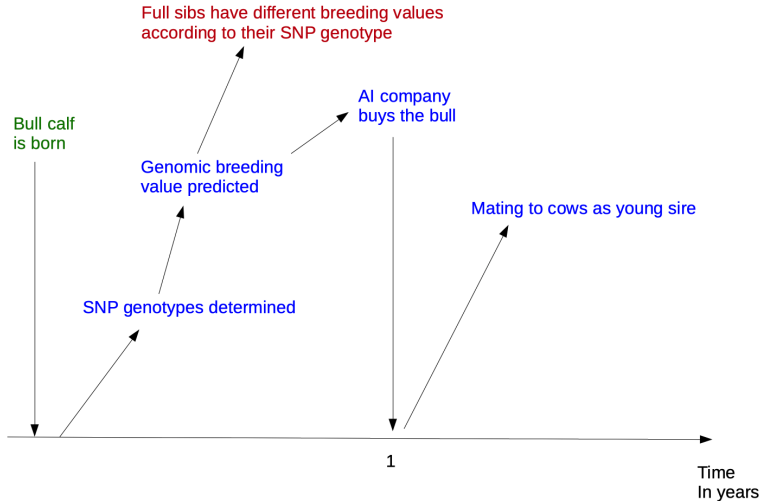
Performance Testing



Genomic Selection

- ▶ SNP Genotype can be determined when calf is born
- ▶ Genomic Breeding value can be computed as soon as SNP genotype is determined
- ▶ Full sibs get different genomic breeding values → increase accuracy

Genomic Selection (II)

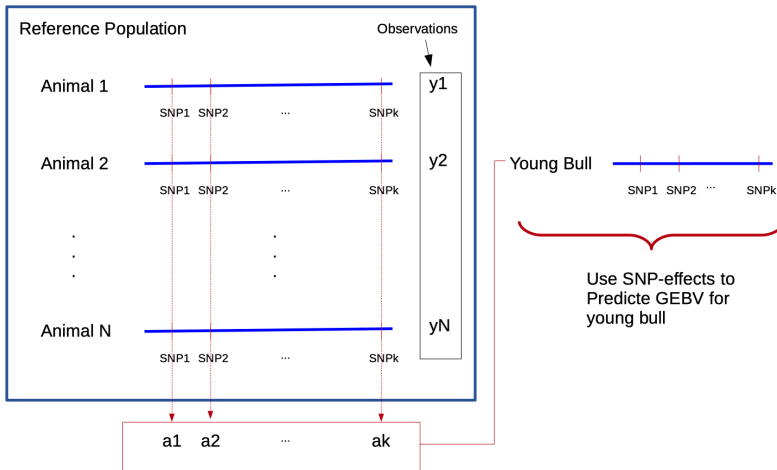


Prediction of Genomic Breeding Values

Genomic breeding values can be predicted using either

- ▶ Two step approach or
- ▶ Single step GBLUP

Two Step Approach



Estimate SNP-effects using a Marker Effect Model

Single Step GBLUP

- ▶ Use a mixed linear effect model
- ▶ Genomic breeding values g are random effects

$$y = Xb + Zg + e$$

with

- ▶ $E(e) = 0, \text{var}(e) = I * \sigma_e^2$
- ▶ $E(g) = 0, \text{var}(g) = G * \sigma_g^2$
- ▶ Genomic relationship matrix G

Solution Via Mixed Model Equations

- ▶ All animals have genotypes and observations

$$\begin{bmatrix} X^T X & X^T Z \\ Z^T X & Z^T Z + \lambda * G^{-1} \end{bmatrix} \begin{bmatrix} \hat{b} \\ \hat{g} \end{bmatrix} = \begin{bmatrix} X^T y \\ Z^T y \end{bmatrix}$$

with $\lambda = \sigma_e^2 / \sigma_g^2$.

Animals Without Observations

- ▶ Young animals do not have observations
- ▶ Partition \hat{g} into
 - ▶ \hat{g}_1 animals with observations and
 - ▶ \hat{g}_2 animals without observations
- ▶ Resulting Mixed Model Equations are (assume $\lambda = 1$)

$$\begin{bmatrix} X^T X & X^T Z & 0 \\ Z^T X & Z^T Z + G^{(11)} & G^{(12)} \\ 0 & G^{(21)} & G^{(22)} \end{bmatrix} \begin{bmatrix} \hat{b} \\ \hat{g}_1 \\ \hat{g}_2 \end{bmatrix} = \begin{bmatrix} X^T y \\ Z^T y \\ 0 \end{bmatrix}$$

Predicted Genomic Breeding Values

- ▶ Last line of Mixed model equations

$$G^{(21)} \cdot \hat{g}_1 + G^{(22)} \cdot \hat{g}_2 = 0$$

Solutions

- Solving for \hat{g}_2

$$\hat{g}_2 = -(G^{(22)})^{-1} \cdot G^{(21)} \cdot \hat{g}_1$$