Accuracies of EBVs:

Standard Errors of EBVs *vs*. Response to Selection

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The role of accuracy (ρ) in animal breeding

1. Response to selection: $R = \frac{i\rho\sigma_A}{L}$
   - ρ = correlation(EBV,BV)
   - ρ measures the quality of a breeding scheme

2. Credibility of an EBV: $\mathrm{SE}(EBV) = \sqrt{(1-\rho^2)\sigma_A^2}$
   - ρ measures the quality of a single EBV
     - Risk that EBV changes with more info
       - Dairy cattle, horses

Accuracies are routinely produced in BVE

- BVE → Accuracies follow from the PEV: $\rho_{PEV} = \sqrt{\frac{\sigma_A^2 - PEV}{\sigma_A^2}}$
  - Inverse of coefficient matrix of MME
- ρ_{PEV} is a convenient proxy for response to selection
  - Often routinely available
  - Easily compare individuals with different info
- Example: Dairy cattle
  - Parent Average: $\rho_{PEV} = 0.55$ (rel. = 0.3)
  - + 1st lactation: $\rho_{PEV} = 0.64$ (+15%)

Conclusion:

Waiting for 1st lactation record yields ~15% more response

- However, ρ_{PEV} ignores selection (Selection matters: Dekkers, 1992 Anim. Prod. 54)
  - The above may be somewhat erroneous

Objective

- To demonstrate that:
  - Ordinary accuracies of EBVs may not at all reflect response to selection
  - The error can be much greater than the usual Bulmer-effect
  - SE(EBV) and Corr(EBV,BV) are different things
    - There exists no single “accuracy” reflecting both measures

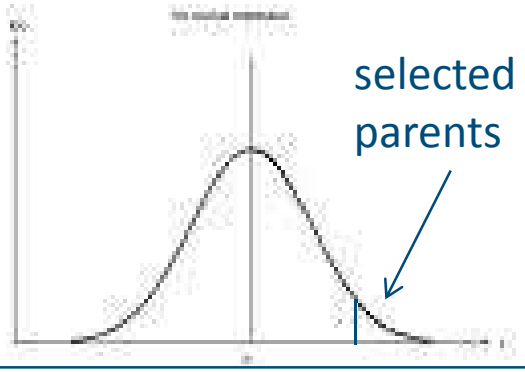
The accuracy of the Parent Average (PA)

Accuracy defined as correlation(EBV,BV)

$$PA = (EBV_S + EBV_D)/2$$

No selection: $Var(PA) = \frac{1}{2} Var(EBV_{\text{parents}}) \rightarrow \rho_{PA} = \frac{\rho_{\text{parents}}}{\sqrt{2}} \approx 0.71\,\rho_{\text{parents}}$

Selection:



$$Var(EBV_{parents}) = (1-k)Var(EB)$$

$$\rho_{PA} = \sqrt{1-k}\,\frac{\rho_{\text{parents}}}{\sqrt{2}}$$

$$p = 10\% \rightarrow k \approx 0.83 \rightarrow \rho_{PA} \approx 0.29\,\rho_{\text{parents}}$$

Selection strongly reduces Var(EBV) → ρ_{PA} is strongly reduced

Ordinary accuracy from PEV ignores selection

No selection: $\sigma^2_{EBV} = \sigma^2_A - PEV \rightarrow \rho_{PEV} = \sqrt{\frac{\sigma^2_A - PEV}{\sigma^2_A}} = \sqrt{\frac{\sigma^2_{EBV}}{\sigma^2_A}} = corr(A, EBV)$

Selection: $\sigma^2_{EBV} \neq \sigma^2_A - PEV \rightarrow \rho_{PEV} = \sqrt{\frac{\sigma^2_A - PEV}{\sigma^2_A}} \neq \sqrt{\frac{\sigma^2_{EBV}}{\sigma^2_A}} = corr(A, EBV)$

With selection,
the standard error of an EBV (√PEV)
and the correlation between true and estimated BV
are different things.

Comparison of breeding schemes

- The ordinary accuracy systematically overpredicts the value of pedigree information

- This biases the comparison of breeding schemes
  - New information is undervalued
    - Own performance
    - Genomic information
    - Progeny

Example: value of genotyping cows in GS

- Milk yield
  - GS-accuracy = 0.8
  - Selected proportions: 1% in both sexes
  - Bulls are genotyped
- Issue: The effect of genotyping cows on accuracy of their EBV

Method	Parent Avg.	Genotyping	Difference
ρ_{PEV}	0.43	0.78	+81%
Corr(EBV,BV)	0.12	0.68	+466%

5-fold difference

Ordinary accuracy undervalues genomic info in cows

Example: GS for litter size in pigs

- Litter size
  - GS-accuracy = 0.4
  - Selected proportions : 25% in sows, ~2% in boars
  - Selection sows after 1st litter.
    - Info: 1st litter, 3FS, 56HS records
  - Selection of boars: at sexual maturity
    - Info: Parent Average
- Issue: Select boars on Parent Average or Genomic Selection?

Method	Parent Avg.	Genotyping	Difference
ρ_{PEV}	0.31	0.52	+66%
Corr(A,EBV)	0.13	0.36	+182%

2.75-fold difference

Conclusions

- Ordinary accuracies obtained from BVE:
  - Reflect the standard error of an EBV
  - Do not reflect response to selection
    - Cannot be used to compare breeding schemes
  - Overpredict the value of pedigree information for response
- Accuracies relevant for response can be obtained from:
  - Selection-index calculations
    - e.g. SelAction, not SELIND
  - SD_{EBV} /SD_{BV} for Total Merit in the selection candidates
  - (Cross)validation using historical data
- Dairy cattle breeders mix two incompatible concepts of accuracy
  - Monday's session