Development of a genomic evaluation for milk production for a local bovine breed

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The dual purpose Belgian Blue breed (DP-BB) is a vulnerable breed rooted in the tradition of the Walloon Region of Belgium. Those animals have interesting features (e.g., robustness, good longevity, and ease of calving) and the average milk yield is 4,000 kg/lactation (it can reach up to 7,000 kg/lactation). Due to its dual purpose type, income generated by both milk and meat is more stable and more flexible in responding to market fluctuations.

Aims

- To develop a single step genomic evaluation (sGBLUP) for milk production
  - Use of a Bayesian procedure to integrate the Walloon estimated breeding values (EBV) and associated reliability (REL) as a priori known external information
- To choose the best combination of genomic (α) and additive (1 - α) relationships into a merged (co)variance structure

Methodology

Model: Single-Step Bayesian genomic evaluation

\[(H^{-1} + A) \hat{\alpha} = D^{-1} \hat{u}\]

- \(H\): Combined genomic-pedigree based (co)variances matrix (using α)
- \(A = RE \sigma_a^2\): Matrix mining least square part of hypothetical BLUP
- \(RE\): Diagonal matrix with number of records equivalents (RE) free of relationships contributions for each animals
- \(\hat{\alpha}\): Walloon GEBV
- \(D^{-1} = G^{-1} + A\): Inverse of prediction error (co)variances matrix of \(\hat{u}\)
- \(G\): Pedigree based (co)variances matrix
- \(\hat{u}\): Available and predicted EBV
- REL for GEBV (GREL) obtained through inversion of left-hand side

Data

- 3,799 DP-BB animals
- Milk yield EBVs and associated REL from evaluation
  - Based on data recorded until 31/01/2013 – EBV and REL
  - Based on data recorded until 31/01/2009 – EBV₄ and REL₄
- 363 genotyped animals
  - 209 bulls and 154 cows
  - 39,157 SNP after editing

Parametrization

- 200 computations: α from 0.01 to 1.00 by 0.01
  - GEBV and GREL from evaluation using EBV and REL
  - GEBV₄ and GREL₄ from evaluation using EBV₄ and REL₄
- Deregressed proof (DRP) computed from EBV and REL
- For each of 100 possible α, regression of DRP on GEBV₄ with REL as a weight

Conclusions

- Best combination genomic-pedigree with α = 0.65
- Feasibility of modified sGBLUP for a small breed
  - Reliability increases for genotyped animals with small REL in polygenic evaluation when using modified sGBLUP

Results

- Determination coefficients (R²) of the regression of DRP on GEBV₄ for the 100 possible α
  - Average reliability (SD) associated to EBV and GEBV REL and GREL, respectively for genotyped bulls by class of REL

<table>
<thead>
<tr>
<th>Class of REL</th>
<th>N</th>
<th>REL</th>
<th>GREL (α = 0.65)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.25</td>
<td>17</td>
<td>0.14 (0.09)</td>
<td>0.24 (0.12)</td>
</tr>
<tr>
<td>0.25 – 0.49</td>
<td>69</td>
<td>0.38 (0.06)</td>
<td>0.40 (0.06)</td>
</tr>
<tr>
<td>0.50 – 0.74</td>
<td>53</td>
<td>0.60 (0.07)</td>
<td>0.61 (0.07)</td>
</tr>
<tr>
<td>≥ 0.75</td>
<td>70</td>
<td>0.87 (0.06)</td>
<td>0.87 (0.06)</td>
</tr>
</tbody>
</table>

- Increase of REL for genotyped animals (▲ = cows, ■ = bulls, ● = bulls not yet included in polygenic evaluation) sired by genotyped bulls when α = 0.65