Optimal Contribution Selection in Breeding Schemes with Multiple Selection Stages

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Background

• Management of inbreeding is vital because
  – Decline in fitness
  – Decline in genetic variation

• Key to animal breeding:
  – balance inbreeding vs genetic gain
  – Optimal Contribution (OC) selection
Background

• But OC selection assumes
  – one (final) selection step of parents

• In practice: often pre-selection steps
  – account for consideration of relationship in final step

AIM

• Extend OC towards several selection stage
How?

• use OC selection at each stage?
  – But what ΔF (restriction) to use?

• Solution: simultaneously optimize all stages
OC selection & overlapp. gens

– Split population in q age classes (years)
– Control aver. relations & max gain in year t+1
  • Years 1..q simply get one year older: 2..q+1
  • Year 1 is defined by selection of parents => optimise
Several selection steps

• Optimise all selection stages same time:
  – Some age_classes just become 1 year older
  – Some age classes involve a selection stage
  – Relationships of entire population are contrained
  – Gain of entire population is maximised
Result: simulation (mimic sheep selection)

- Dataset
  - # of candidates
    - Stage 1: 500
    - Stage 2: 33

- Case 1:
  - Stage 1: truncation
  - Stage 2: single stage OC selection

- Case 2:
  - Multi-stage OC selection

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<thead>
<tr>
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<th>Case 1</th>
<th>Case 2*</th>
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</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>273</td>
<td>273</td>
</tr>
<tr>
<td>Stage 2</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>Genetic gain</td>
<td>2.41</td>
<td>2.40</td>
</tr>
<tr>
<td>Relationship</td>
<td>0.1650</td>
<td>0.1579</td>
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</tbody>
</table>

* ΔF=0.01

- Results are same with respect to ΔG
- Lower relationship with multi-stage OC
Result: real sheep breeding dataset

- **Dataset**
  - # of candidates
    - Stage 1: 1977
    - Stage 2: 346

- **Case 1:**
  - Stage 1: truncation
  - Stage 2: single-stage OC selection using stage 1 information

- **Case 2:**
  - Multi-stage OC selection

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<td>Stage 2</td>
<td>26</td>
<td>15</td>
</tr>
<tr>
<td>Genetic gain</td>
<td>15.92</td>
<td>19.25</td>
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</tbody>
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* ΔF=0.01

• Higher ΔG with multi-stage OC

20.9%
Discussion

• Simultaneous optimization possible

• But, may not be practical
  – Assumes simultaneous selection at all stages
  – Practice do the preselection stage first
  – If the actual selection is different from optimum
    • re-run OC with single (final) selection stage
Conclusions

- **multistage OC**: optimises multistage selection
  - Control of relationships
  - Maximise gains

- Sheep breeding example: extra gains

- More than two selection stages:
  - Straightforward extension
Thank you!

Acknowledgements: NSG