longitudinal residual feed intake criterion for selection

Ingrid David, Van-Hung Huynh Tran, Hélène Gilbert

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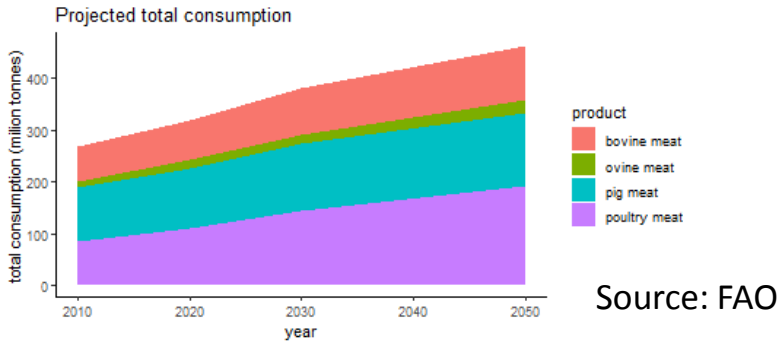
Context

Forecast : Increase global meat consumption



Source: FAO

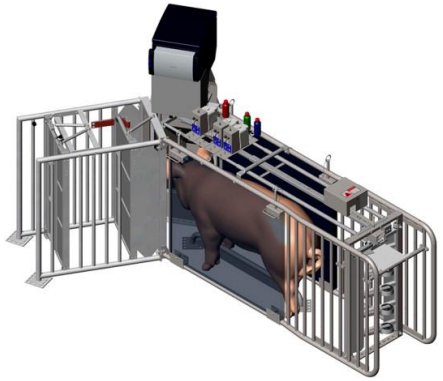
Needs : Increase in meat production

Solution :Improve feed efficiency

Residual feed intake (RFI)

RFI = observed FI corrected by predicted FI based on production and maintenance requirements

New tools : Development automatic self-feeders



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New data : Longitudinal FI, MBW, ADG, BF

Longitudinal RFI

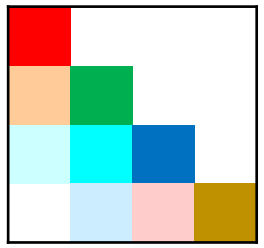
Reminder: genetic improvement RFI – single record

RFI = *observed FI* corrected by predicted FI based on production and maintenance requirements

Traits: **FI ADG MBW BF**

Method selection:
- Index **FI ADG MBW BF**
- Index **RFI** (phenotypic regression) **ADG MBW BF**
- **RFI** (genetic regression)

FI/RFI
ADG
MBW
BF

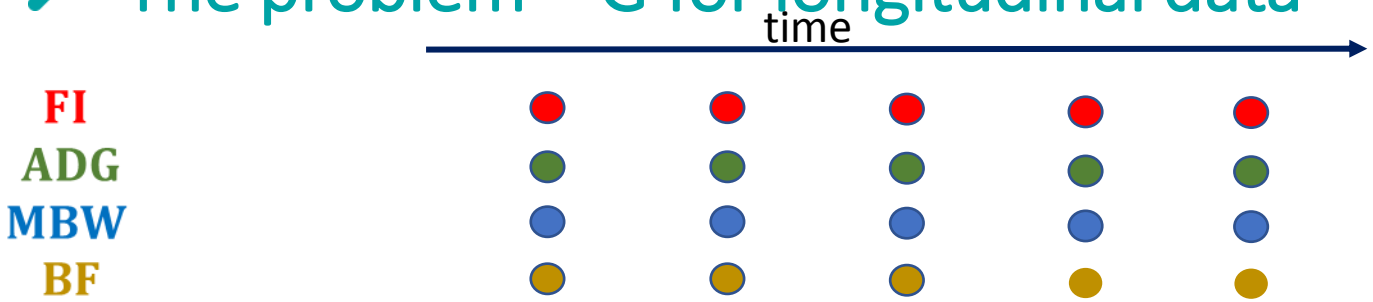


Estimation (4x4) covariance matrices needed

↓

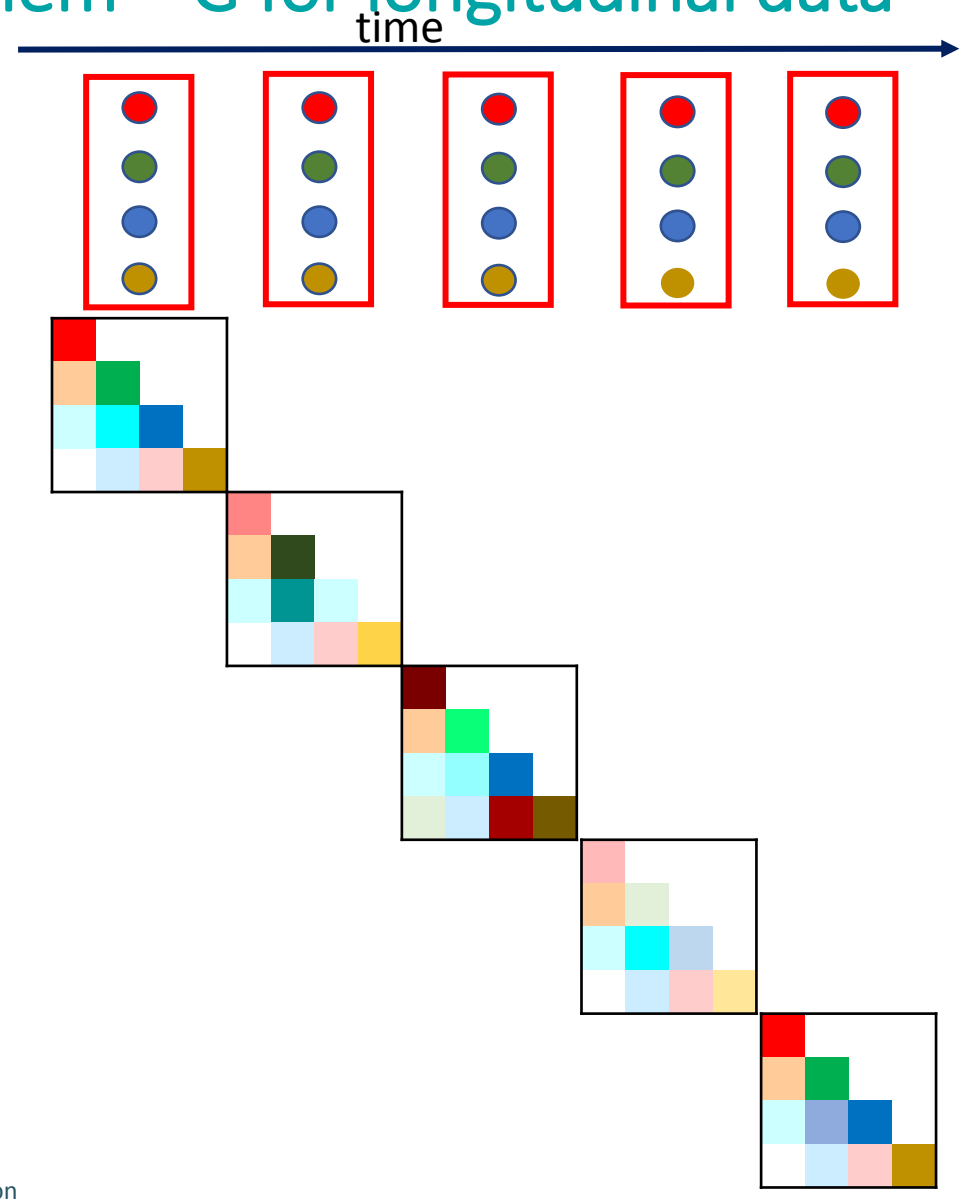
Multiple trait model

The problem – G for longitudinal data



The problem – G for longitudinal data

FI
ADG
MBW
BF



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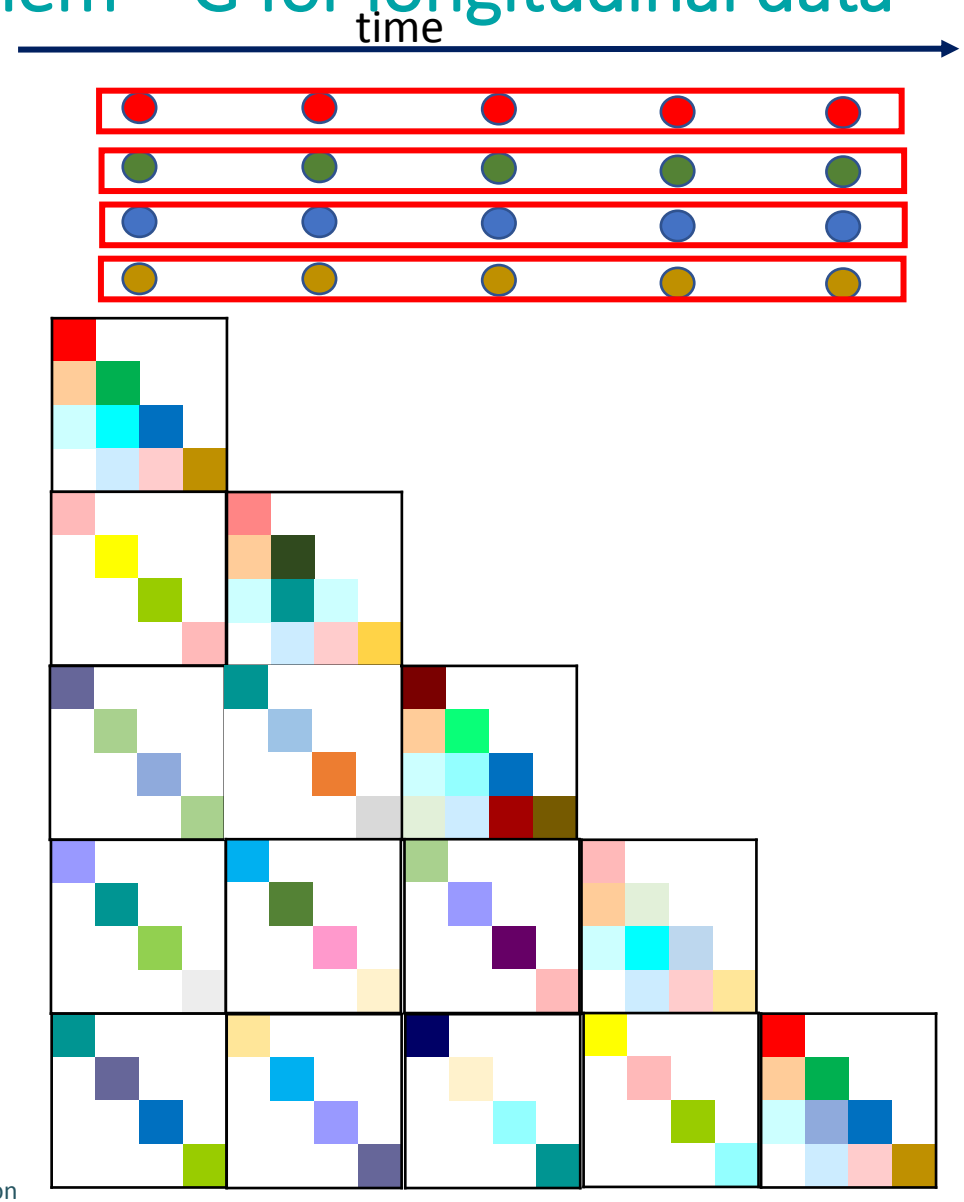

The problem – G for longitudinal data

FI
ADG
MBW
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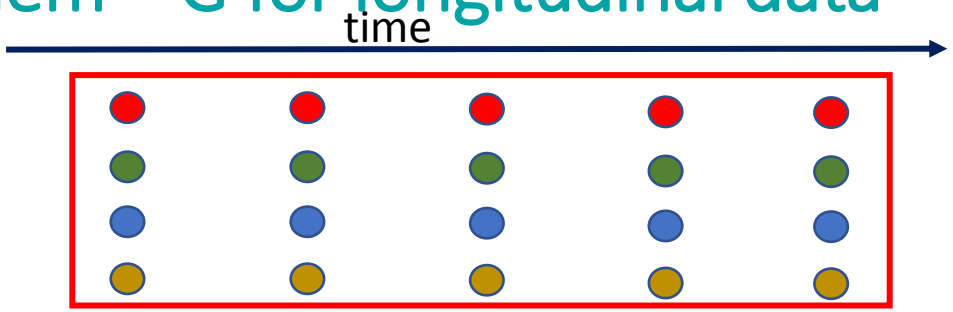
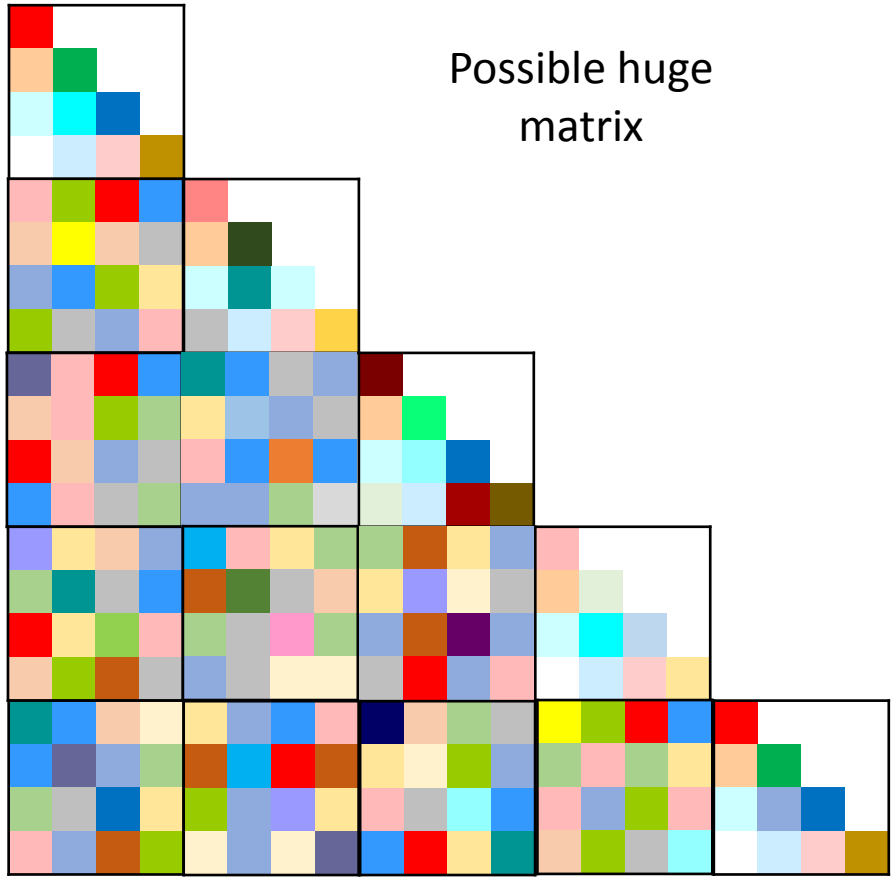
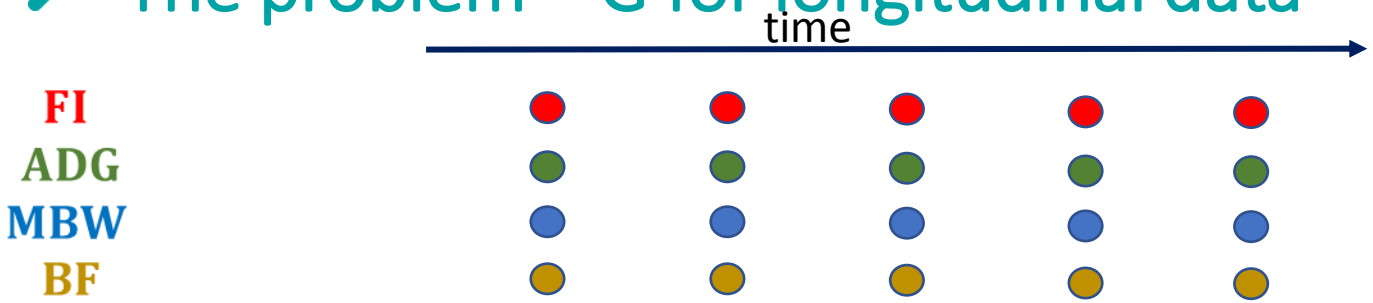


Possible huge matrix

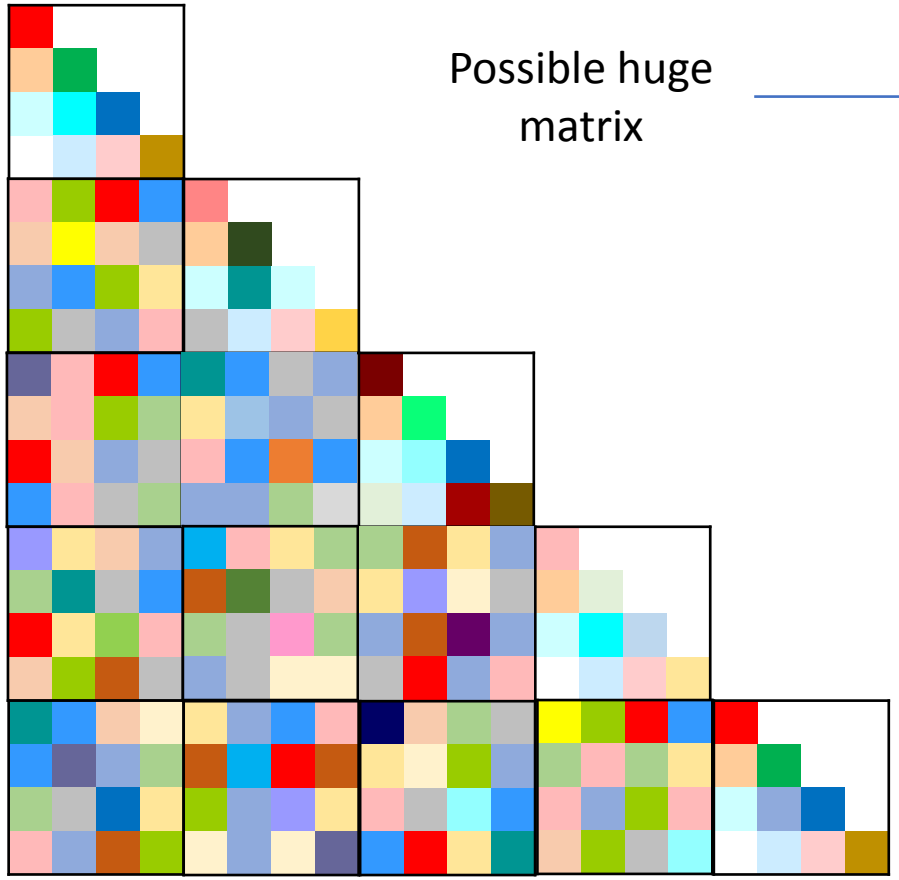
G



The problem – G for longitudinal data



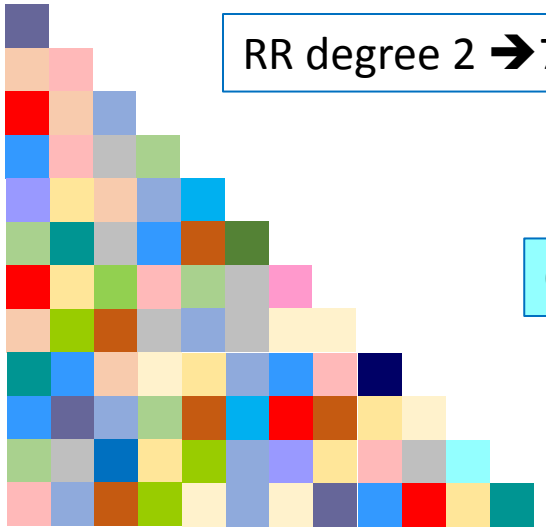
G



Possible huge matrix →

Longitudinal models

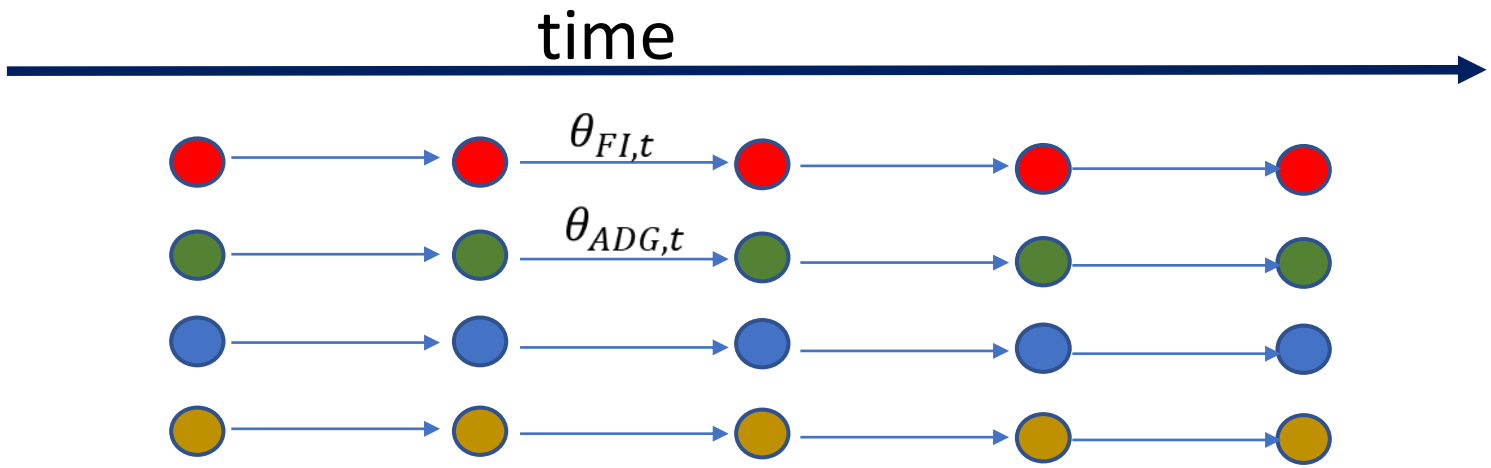
Random regression ?



RR degree 2 ➔78 parameters

Convergence issues

The proposed solution: multiple trait structured antedependence model

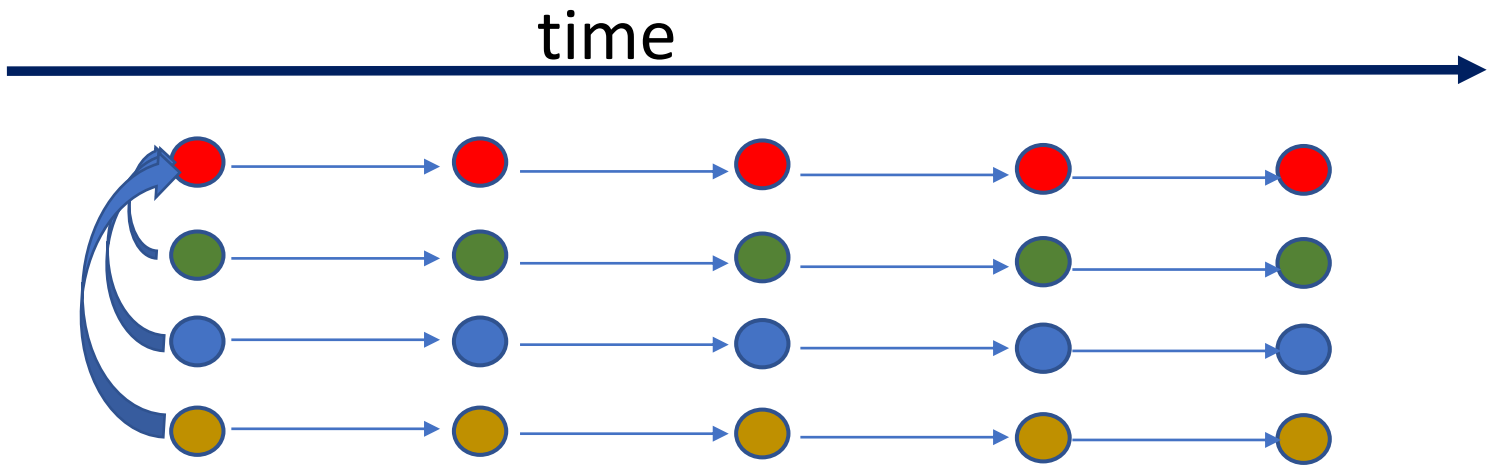


FI
ADG
MBW
BF

$$\mathbf{u_{FI,t}} = \theta_{FI,t}\mathbf{u_{Fi,t-1}} + \boldsymbol{\varepsilon_{FI,t}}$$
$$\mathbf{u_{ADG,t}} = \theta_{ADG,t}\mathbf{u_{ADG,t-1}} + \boldsymbol{\varepsilon_{ADG,t}}$$
$$\mathbf{u_{MBW}} = \ldots$$
$$\mathbf{u_{BF}} = \cdots$$

The proposed solution: multiple trait structured antedependence model

FI
ADG
MBW
BF



$$\mathbf{u_{FI,t}} = \theta_{FI,t}\mathbf{u_{Fi,t-1}} + \beta_{ADG,t}\mathbf{u_{ADG,}}_{t} + \beta_{MBW,t}\mathbf{u_{MBW,}}_{t} + \beta_{BF,t}\mathbf{u_{BF,}}_{t} + \boldsymbol{\varepsilon_{FI,t}}$$

$$\mathbf{u_{ADG,}}_{t} = \theta_{ADG,t}\mathbf{u_{ADG,t-1}} + \boldsymbol{\varepsilon_{ADG,t}}$$

$$\mathbf{u_{MBW}} = \ldots$$

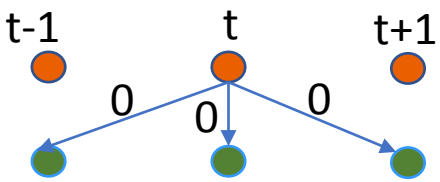
$$\mathbf{u_{BF}} = \cdots$$

The proposed solution: multiple trait structured antedependence model

$$\mathbf{u_{FI,t}} = \theta_{FI,t}\mathbf{u_{Fi,t-1}} + \beta_{ADG,t}\mathbf{u_{ADG,t}} + \beta_{MBW,t}\mathbf{u_{MBW,t}} + \beta_{BF,t}\mathbf{u_{BF,t}} + \boldsymbol{\varepsilon_{FI,t}}$$

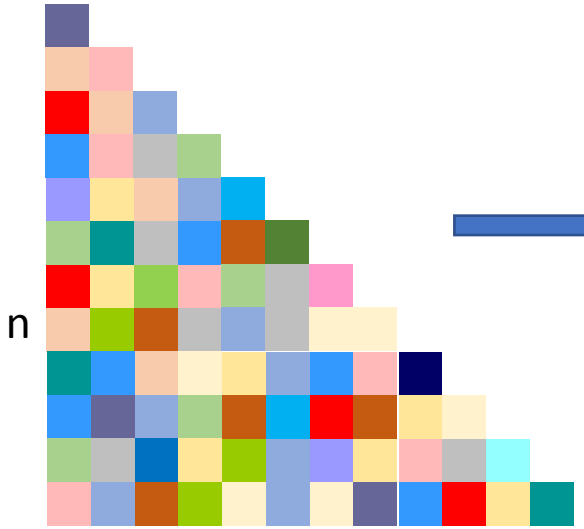
RFI

ADG, MBW, BF



n $\mathbf{u_{RFI,t}}$ independent from $\mathbf{u_{ADG}}$, $\mathbf{u_{MBW}}$, $\mathbf{u_{BF}}$

$\mathbf{G_{RFI}}$



Eigen decomposition

$$\mathbf{G_{RFI}}\mathbf{L'}_i = \lambda_i \mathbf{L'}_i$$

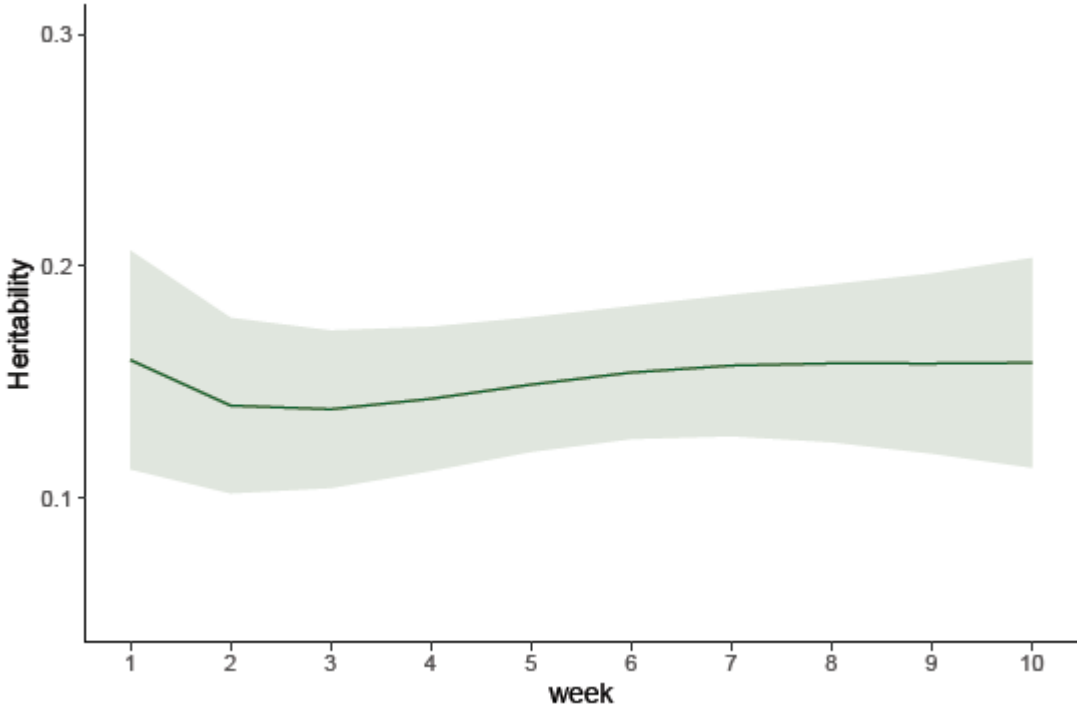
Summarized breeding values

$$\mathrm{SBV_i} = \mathbf{L}_i \mathbf{u_{RFI}}$$

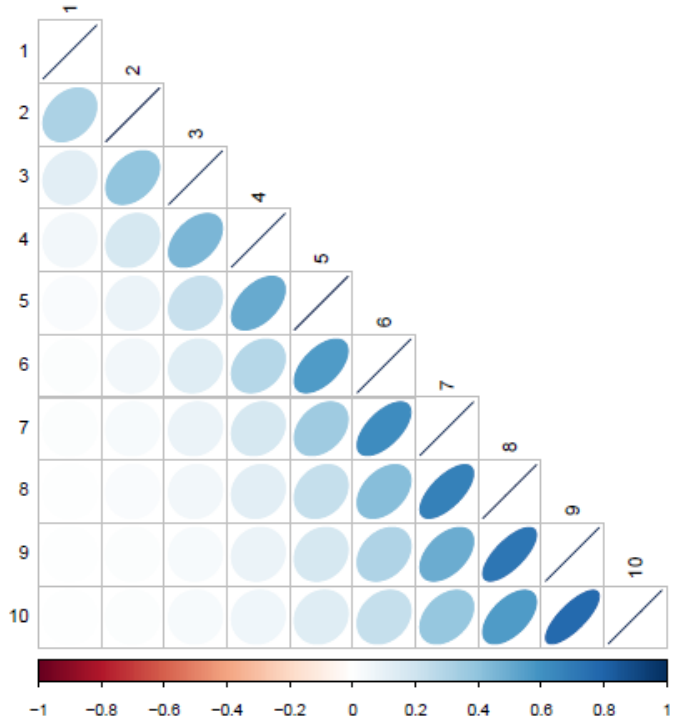
Application to pig data

- 2435 growing french Large White pigs
- 2 lines divergently selected for RFI obtained by phenotypic regression at the test period level (one observation / animal)
- 10 weeks of observation

Results: heritability and genetic correlation for RFI

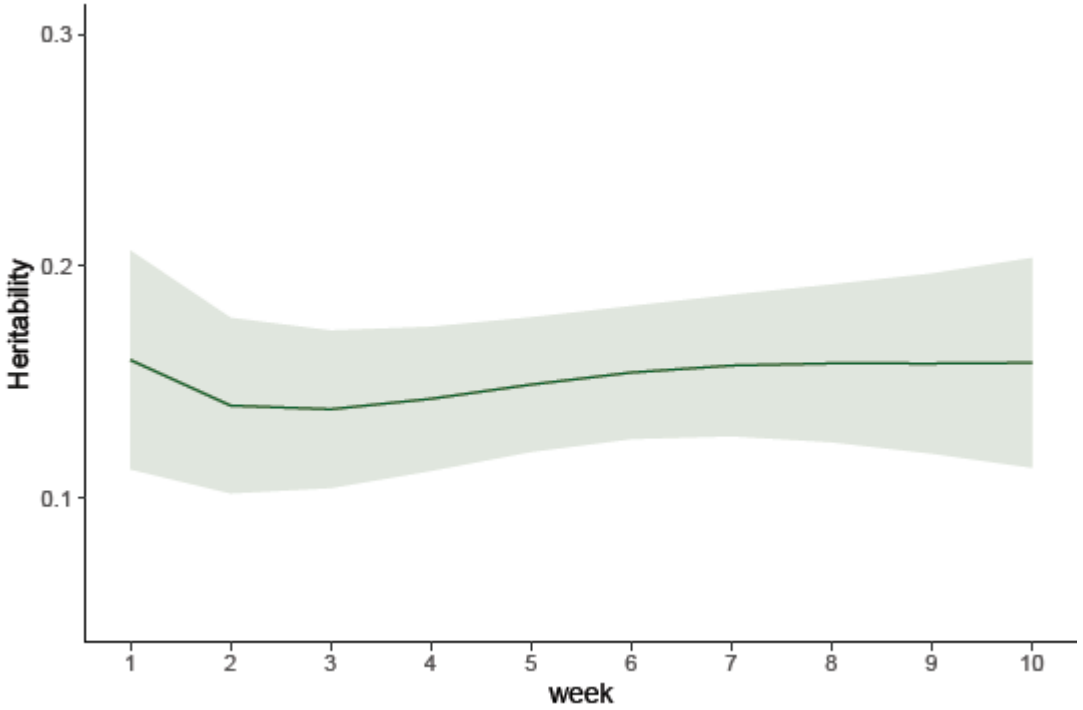


Moderate heritability for RFI

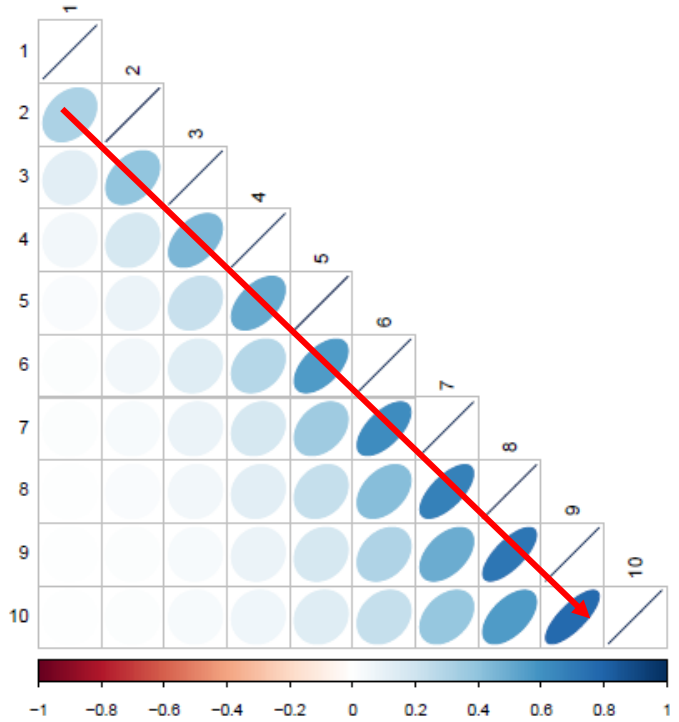


Genetic correlation between RFI that decreased with time interval between measurements

Results: heritability and genetic correlation for RFI



Moderate heritability for RFI



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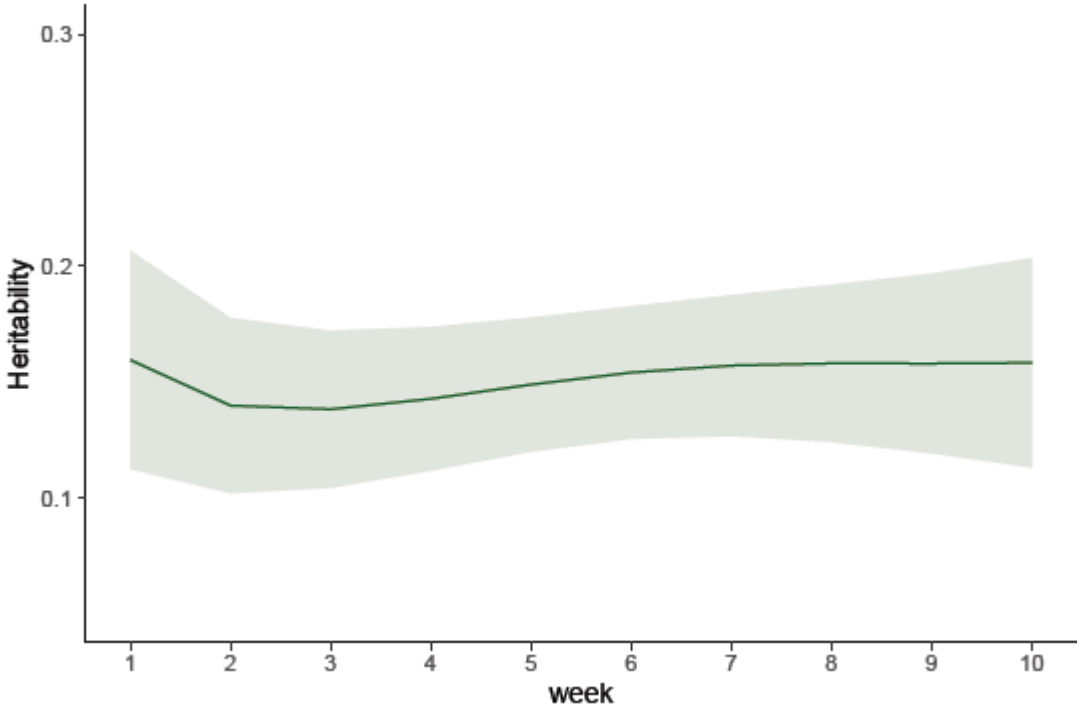

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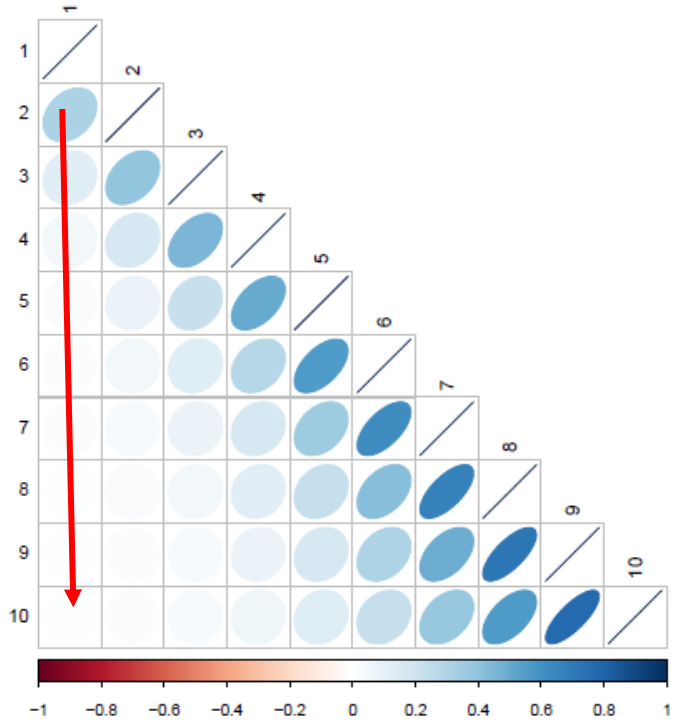
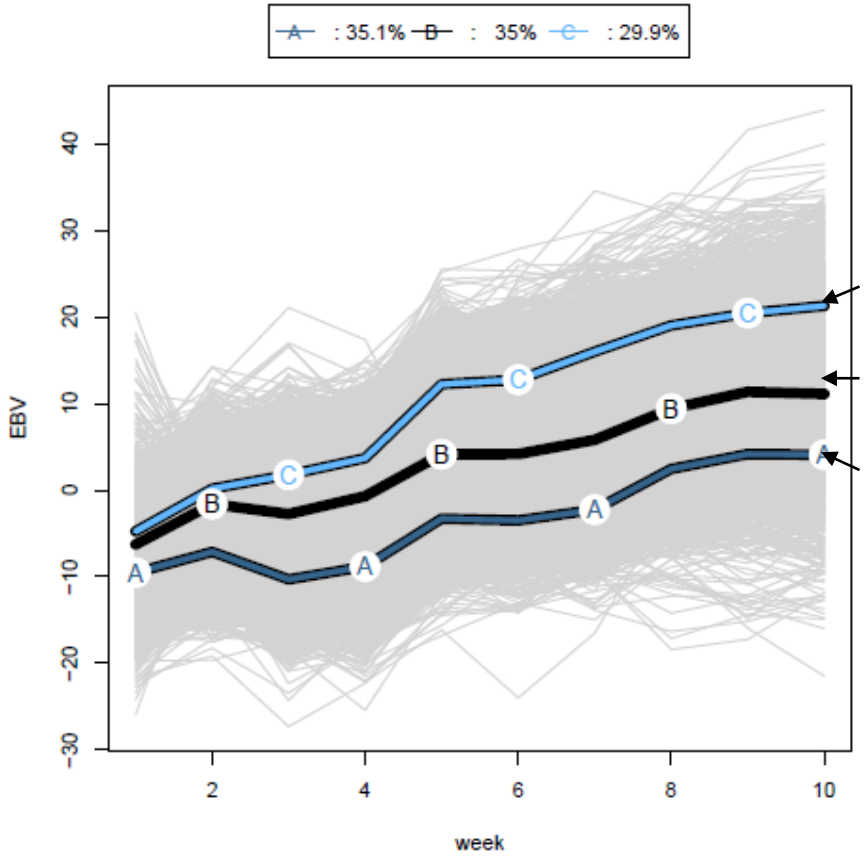
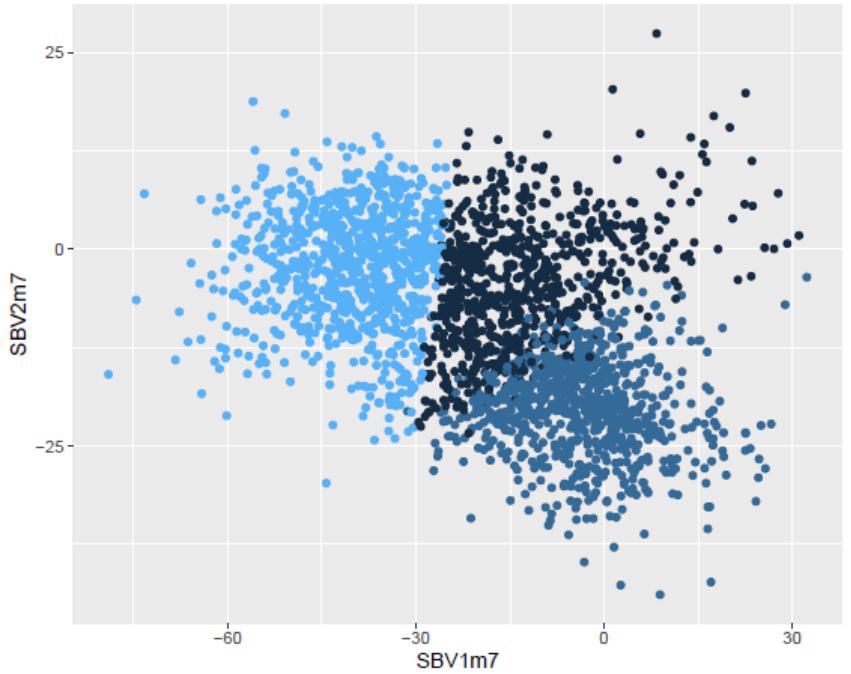


Genetic correlation between RFI that decreased with time interval between measurements

EBV trajectory patterns





Conclusion

- SAD approach permits to model longitudinal RFI
  - ✓Compute genetic and environmental covariance matrices between traits
  - ✓RFI genetically independent from production traits at all time points
  - ✓Trajectory patterns summarized into a limited number of SBV

- Which trajectory is the most interesting?

David, I., Huynh Tran, VH. & Gilbert, H. (2021) New residual feed intake criterion for longitudinal data. Genet Sel Evol 53, 53. https://doi.org/10.1186/s12711-021-00641-2

David, I. (2017, September 19). New fortran programs for genetic studies with structured antedependence models (Version V2). Zenodo. http://doi.org/10.5281/zenodo.1228058.