Joint estimation of curves for weight, feed intake, rate of gain, and residual feed intake

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Introduction

- **Efficiency in growing animals is usually based on longitudinal measures of feed intake and body weight**
- **Potential derived measures**
  - Average Daily Gain
  - Residual Feed Intake
- **Goal of this presentation!**
  - Show that genetic parameters and breeding values for derived measures can be based on an analysis of the measured tratis only.
  - Use an example in beef cattle

Residual Feed Intake (RFI)

$$RFI = FI - E(FI)$$

$$FI = \mu + b1*WGT + b2*ADG + e$$

$$RFI = e(hat)$$

RFI=FI - E(FI) from feeding standards

Data

- **Data from performance test station for beef cattle**
- **Tested in the period from 6 mo. to 13 mo.**
- **2827 Animals**
- **6 breeds**
- **24391 Animals in pedigree**
- **9284 Recording periods of 2 to 4 weeks**

Traits Measured

WGT = Average weight in a recording period (weighing interval)

DFI = Average daily feed intake in a recording period

Statistical Model

$$y_{ijkl} = ys_i + breed_j + b_j(a\_age_k)$$
$$+ l_{q_1}(t)' r_j$$
$$+ l_{q_2}(t)' a_k$$
$$+ l_{q_2}(t)' p_k$$
$$+ e_{ijkl}$$

Bayesian analysis using Gibbs Sampling

Covariance Functions

Let $$a_t = \begin{pmatrix} a_{W(t)} \\ a_{F(t)} \end{pmatrix} = l(t)' \begin{pmatrix} a_{k(W)} \\ a_{k(F)} \end{pmatrix}$$

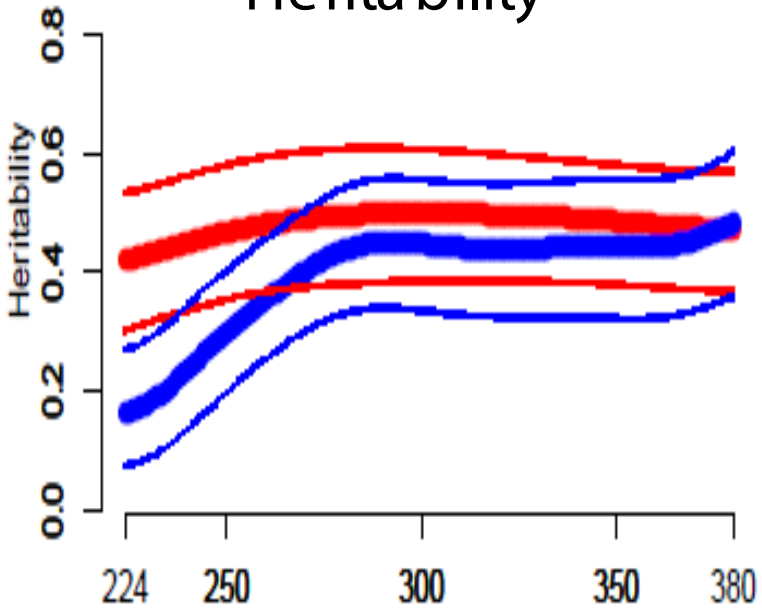
where $$l(t) = \begin{pmatrix} l_{q_2}(t) & 0 \\ 0 & l_{q_2}(t) \end{pmatrix}$$

then $$\mathrm{var}(a_t) = l(t)' \mathbf{G} l(t)$$

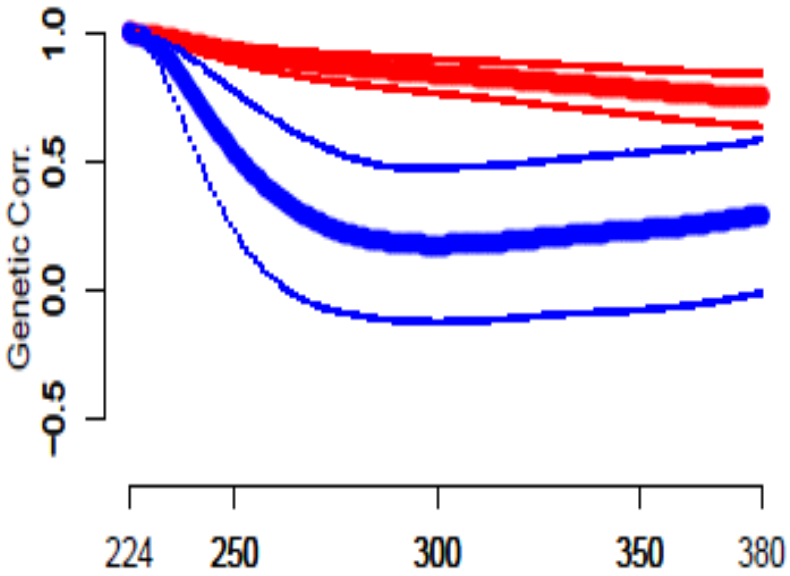
Weight and Daily Feed Intake

WGT=Red,DFI=Blue,

Heritability



r_a with test day 1



Breeding value for daily gain on test day t:

$$a_{G(t)} = \frac{\partial l_{q_2}(t)}{\partial t} a_{k(W)}$$

$$a_{G(t)} \approx \left(l_{q_2}(t+1) - l_{q_2}(t) \right)' a_{k(W)}$$

Breeding value for daily gain over a period:

$$a_{G[t_1,t_2]} = \frac{1}{(t_2 - t_1)} (l_{q_2}(t_2) - l_{q_2}(t_1))' a_{k(W)}$$

Derivation of parameters for RFI (II)

- **Remember:**

$$RFI_t = DFI_t - b_1 * WGT_t - b_2 * G_t$$

I.e. RFI has the conditional distribution of DFI given WGT and G.

We can compute b_1 and b_2 as functions of *t* using Based on the estimated model parameters.

Accumulated Traits

Accumulated FI:

$$a_{T[t_1,t_2]} = \sum_{t=t_1}^{t_2} l_{q_2}(t) a_{k(F)}$$

Average WGT:

$$a_{\bar{W}_{(t_1,t_2)}} = \frac{1}{2}[l_{q_2}(t_2) - l_{q_2}(t_1)]' a_{k(W)}$$

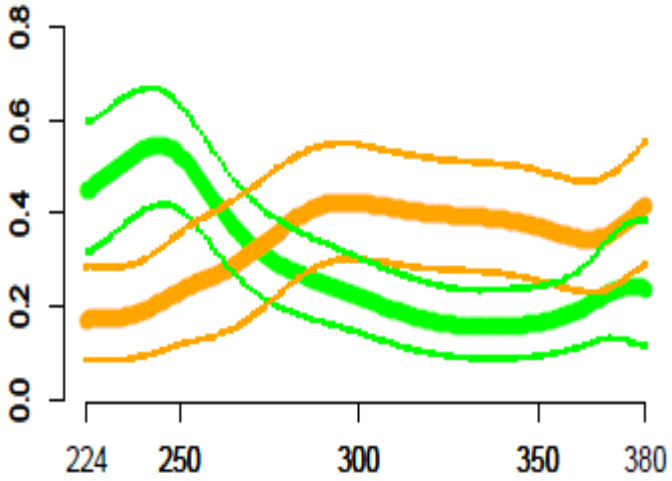
Average Daily Gain:

$$a_{G[t_1,t_2]} = \frac{1}{(t_2 - t_1)}(l_{q_2}(t_2) - l_{q_2}(t_1))' a_{k(W)}$$

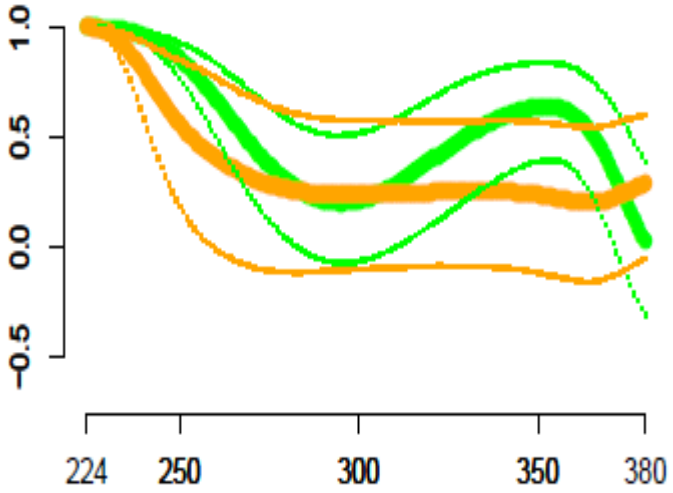
Daily Gain(G) and Daily RFI

G=Green,RFI=Orange

Heritability

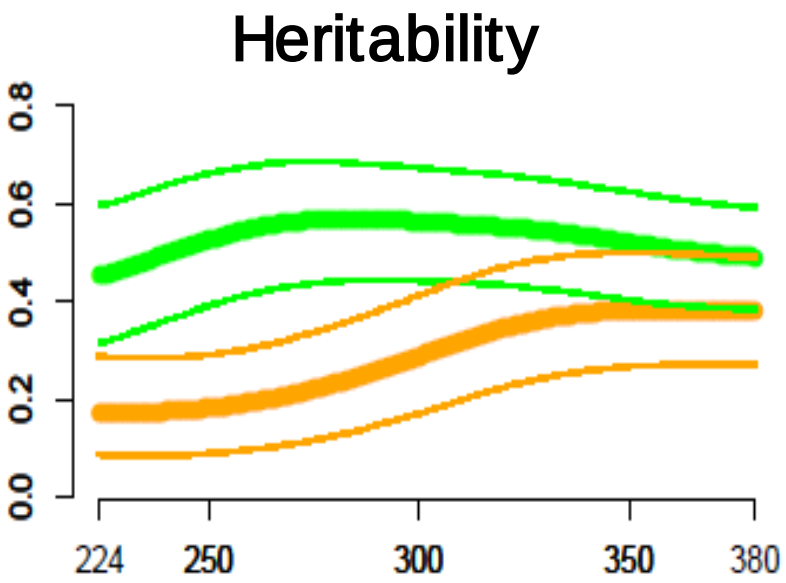


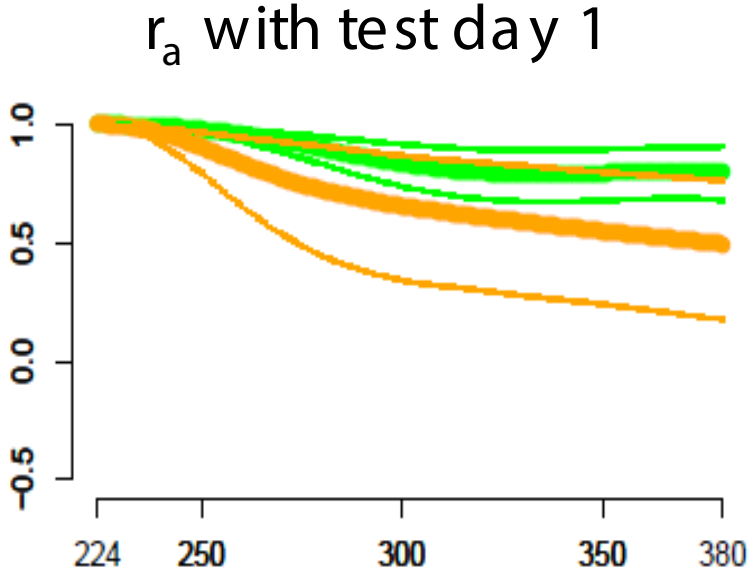
r_a with test day 1



Accumulated Gain and RFI

G=Green,RFI=Orange





Conclusions

- **Population parameters for derived traits such as Gain and RFI can be derived from analysis of basic records of WGT and DFI.**
- **No need to analyze derived traits**
- **Genetic parameters for WGT, FI, G and RFI are time dependent.**
- **Correlation between RFI and other traits depends on definition of RFI w.r.t. time interval**
- **All parameter sets are consistent**

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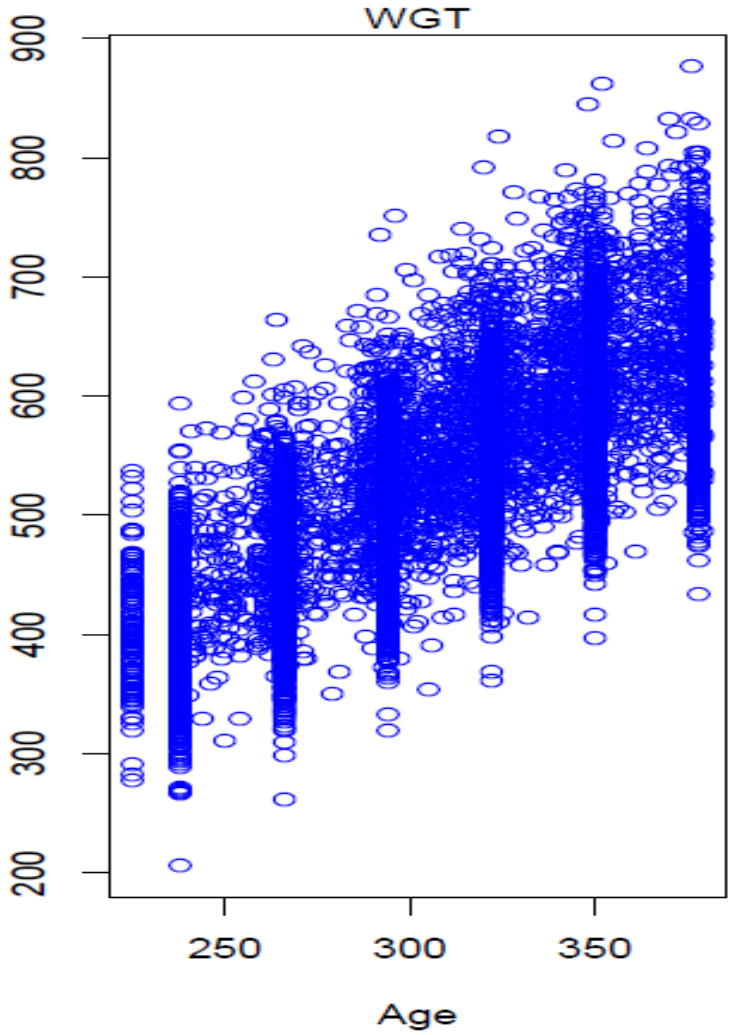
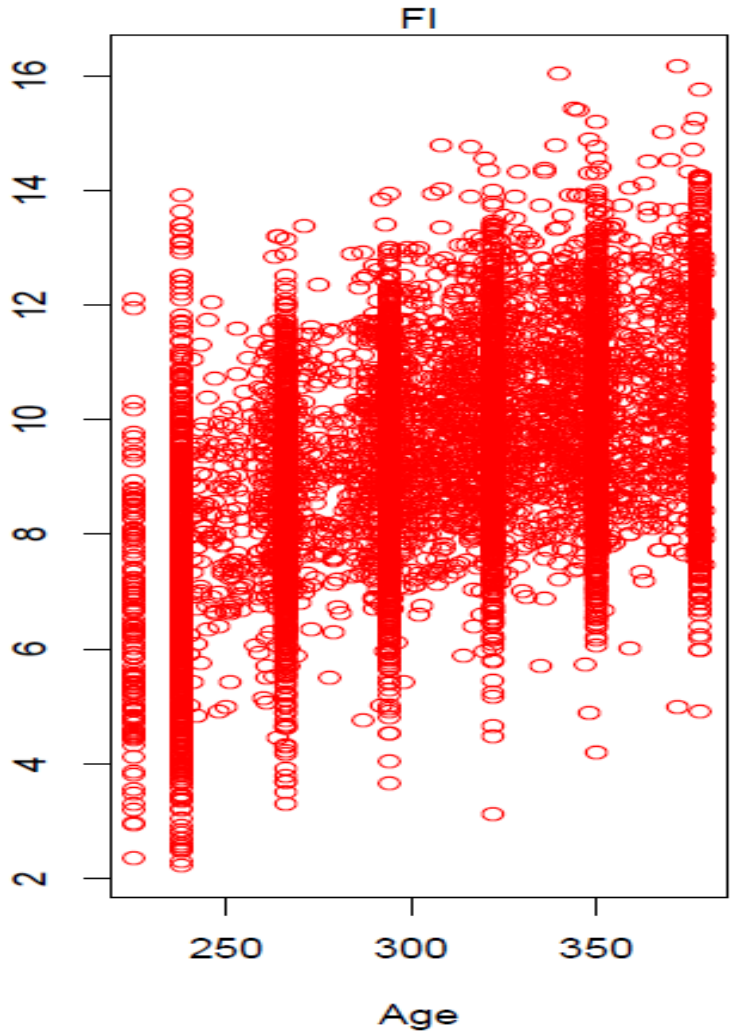
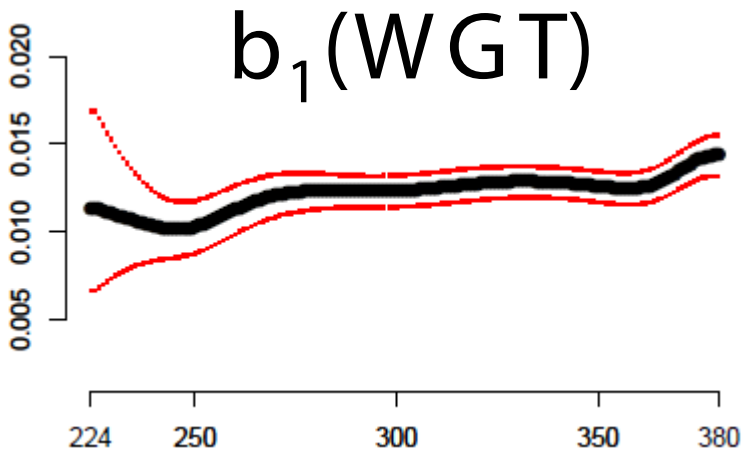
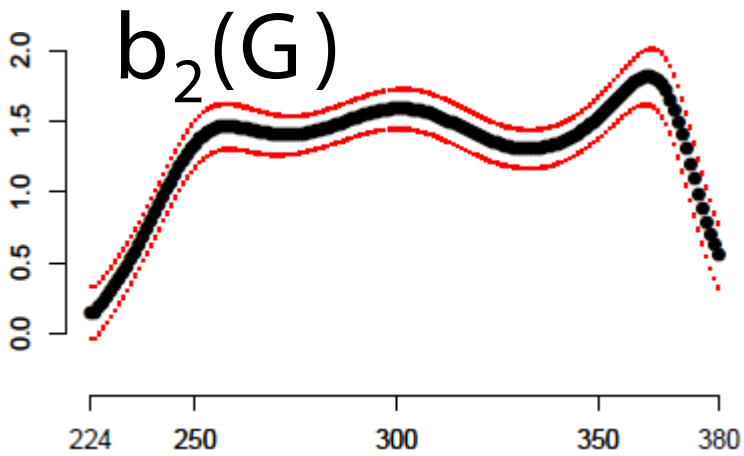
All Data

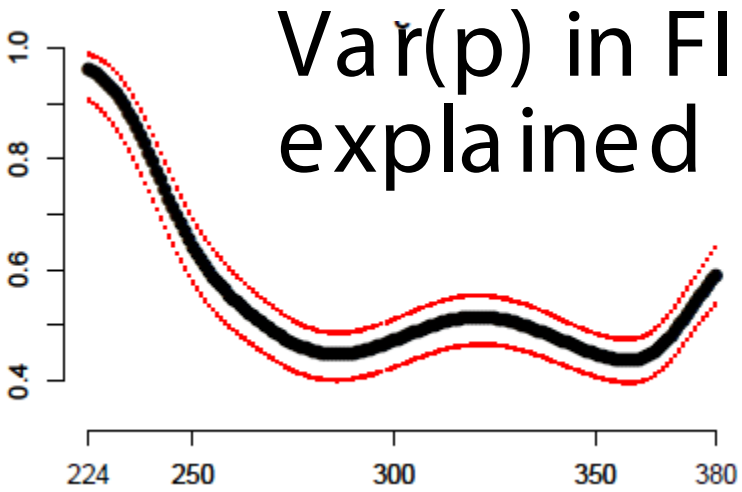




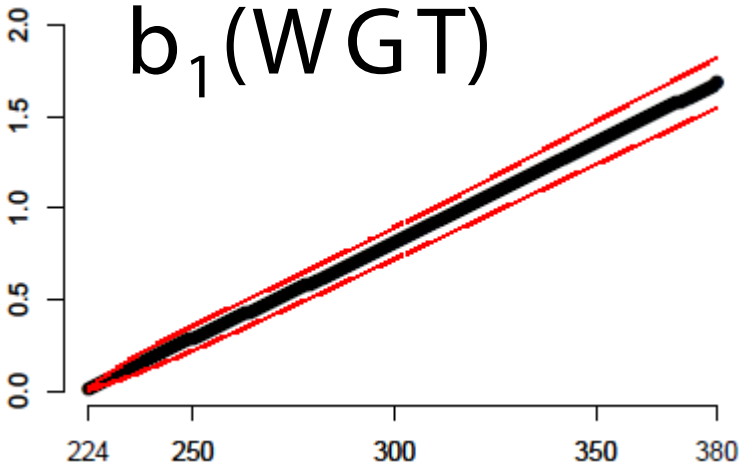
Parameters for computing daily RFI

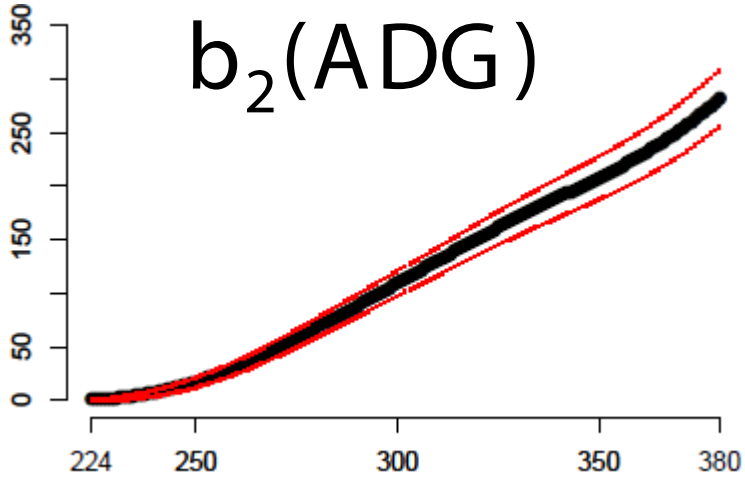


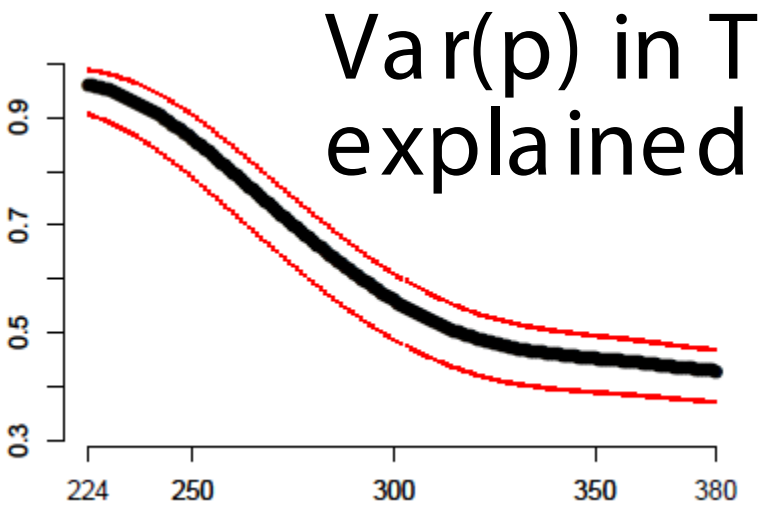




Parameters for computing accumulated RFI







Derivation of parameters for RFI (I)

- **Based on these functions we can derive:**

$$\mathbf{G}_t^* = \mathrm{var}\begin{bmatrix} a_{W(t)} \\ a_{F(t)} \\ a_{G(t)} \end{bmatrix}$$

and similar for other components

so we can compute the phenotypic covariance:

$$\mathbf{P}_t^* = \mathrm{var}\begin{bmatrix} y_{W(t)} \\ y_{F(t)} \\ y_{G(t)} \end{bmatrix}$$

(Co)Variance parameters

G **of order** $2(q_2+1)$

C **of order** $2(q_2+1)$

E **of order** 2 **(measurement error covar.)**

q_2 **chosen to be 4 based on univariate Likelihood ratio tests**

Parameters estimated using Gibbs sampling