Accuracy of estimated breeding values with genomic information on males, females, or both: an example on broiler chicken

Daniela Lourenco

Breno Fragomeni , Shogo Tsuruta, Ignacio Aguilar, Birgit Zumbach, Rachel Hawken, Andres Legarra, Ignacy Misztal

University of Georgia, INIA, INRA, and Cobb Inc.

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QUESTIONS

- Should we genotype females?
- Are they helpful for genomic evaluations?

Situation in dairy Cattle

Population	Trait	Bulls	Bulls + Cows	
Israeli Holsteins	Milk yield	0.24	0.25	Lourenco et al., 2014
US Holsteins	Final Score	0.34	0.35	Tsuruta et al., 2013
US Holsteins	Yield traits	0.41	0.41	Cooper et al., 2015

- Small gains in reliability in dairy cattle
- Bulls with high-reliability genetic merit

Situation in other species

What happens in other species?

- Broiler chickens from Cobb-Vantress
  - Males
  - Females
  - Males + Females

Data Structure

- ~ 200,000 broiler chickens
- Phenotypes for 4 traits
  - Growth_1 $h^2 = 0.28$
  - Efficiency $h^2 = 0.25$
  - Production $h^2 = 0.49$
  - Growth_2 $h^2 = 0.22$
- Over 15,000 genotyped males and females
- 16 micro-generations

Reference & Validation

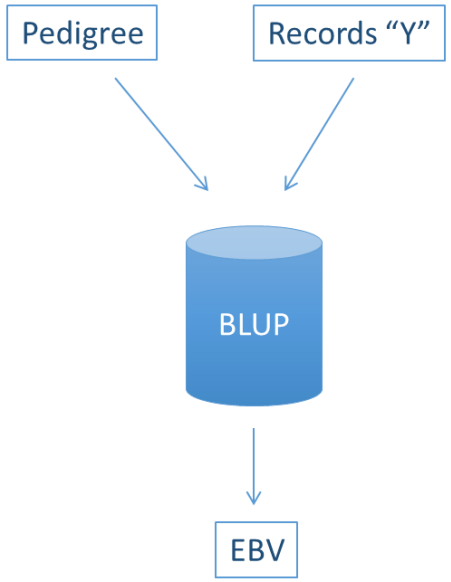
$N_g = 15{,}723$

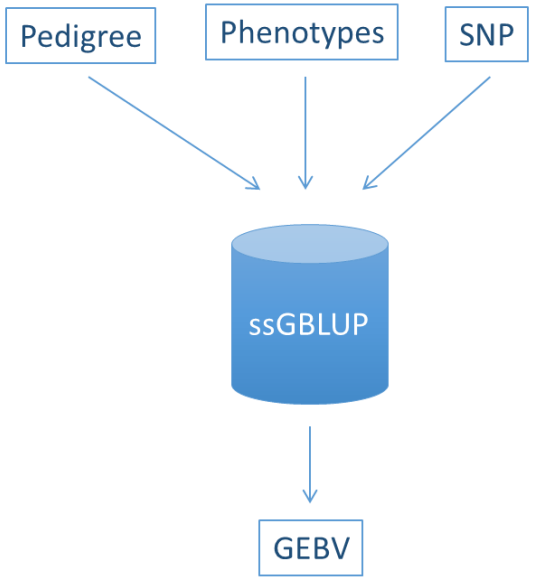
REFERENCE POPULATION

Reference Population

REFERENCE POPULATION	Both sexes 12748	Males 4648	Females 8100	
Growth_1	12748	4648	8100	✓
Efficiency	9567	2010	7557	
Production	2213	2213	0	X
Growth_2	9624	2017	7607	

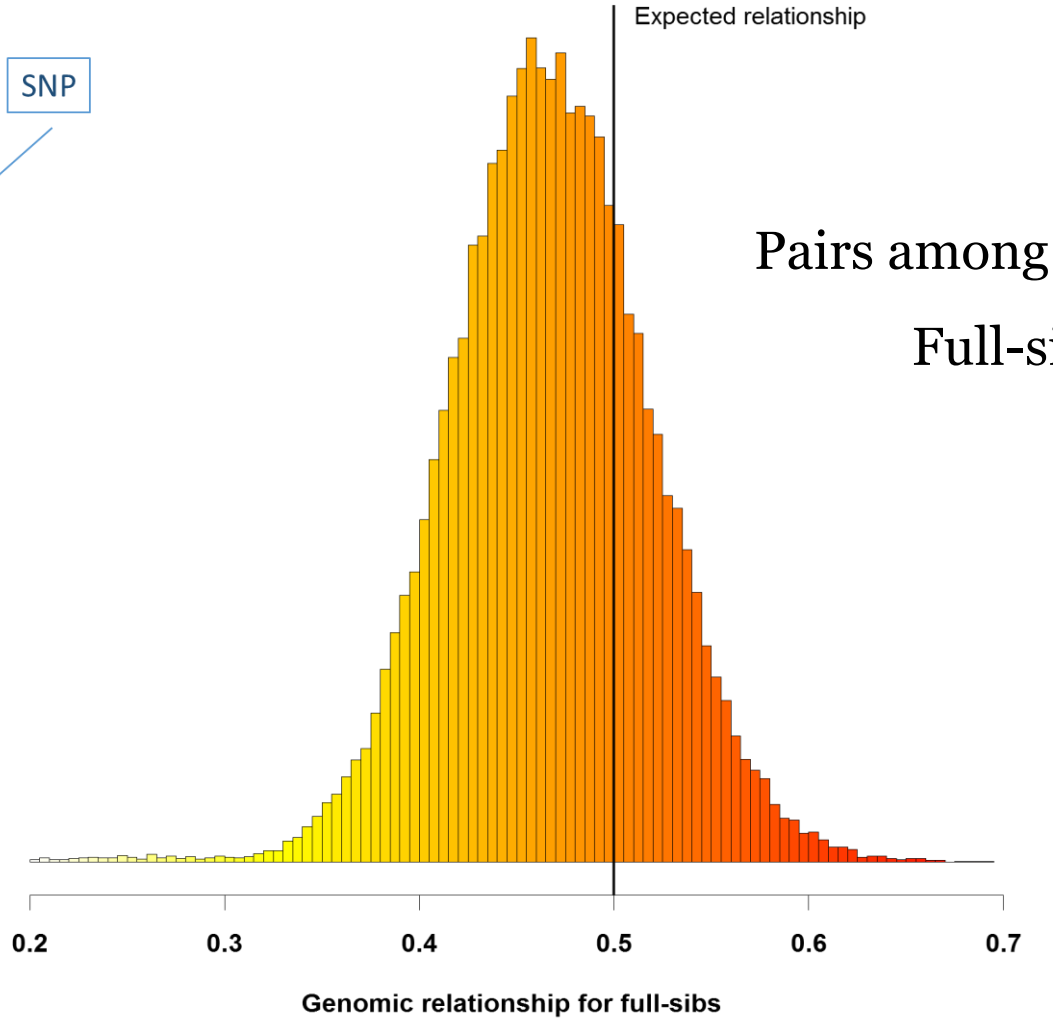
BLUP and ssGBLUP





$$\mathbf{H}^{-1} = \mathbf{A}^{-1} + \begin{bmatrix} 0 & 0 \\ 0 & \mathbf{G}^{-1} - \mathbf{A}_{22}^{-1} \end{bmatrix}$$

Aguilar et al., 2010



Pairs among ~ 14,000

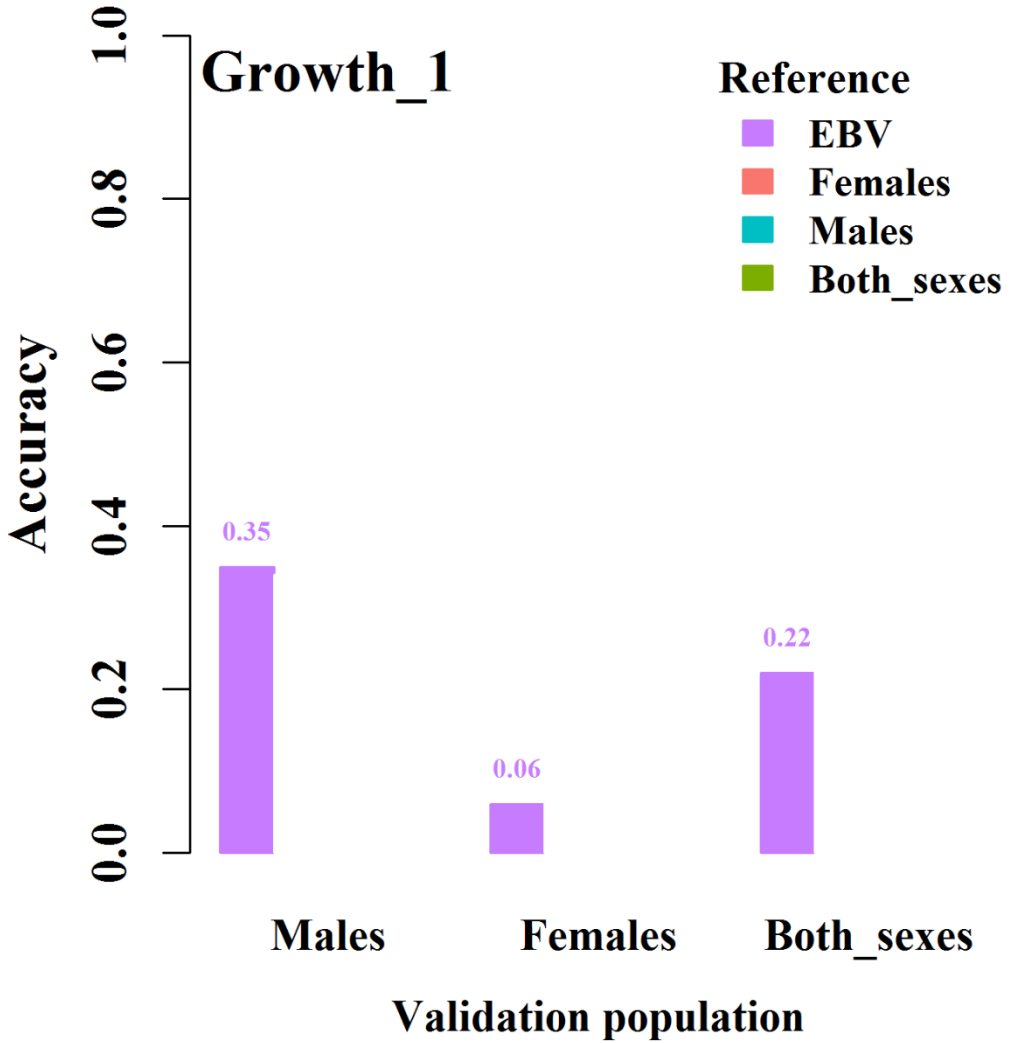
Full-sibs

Validation method

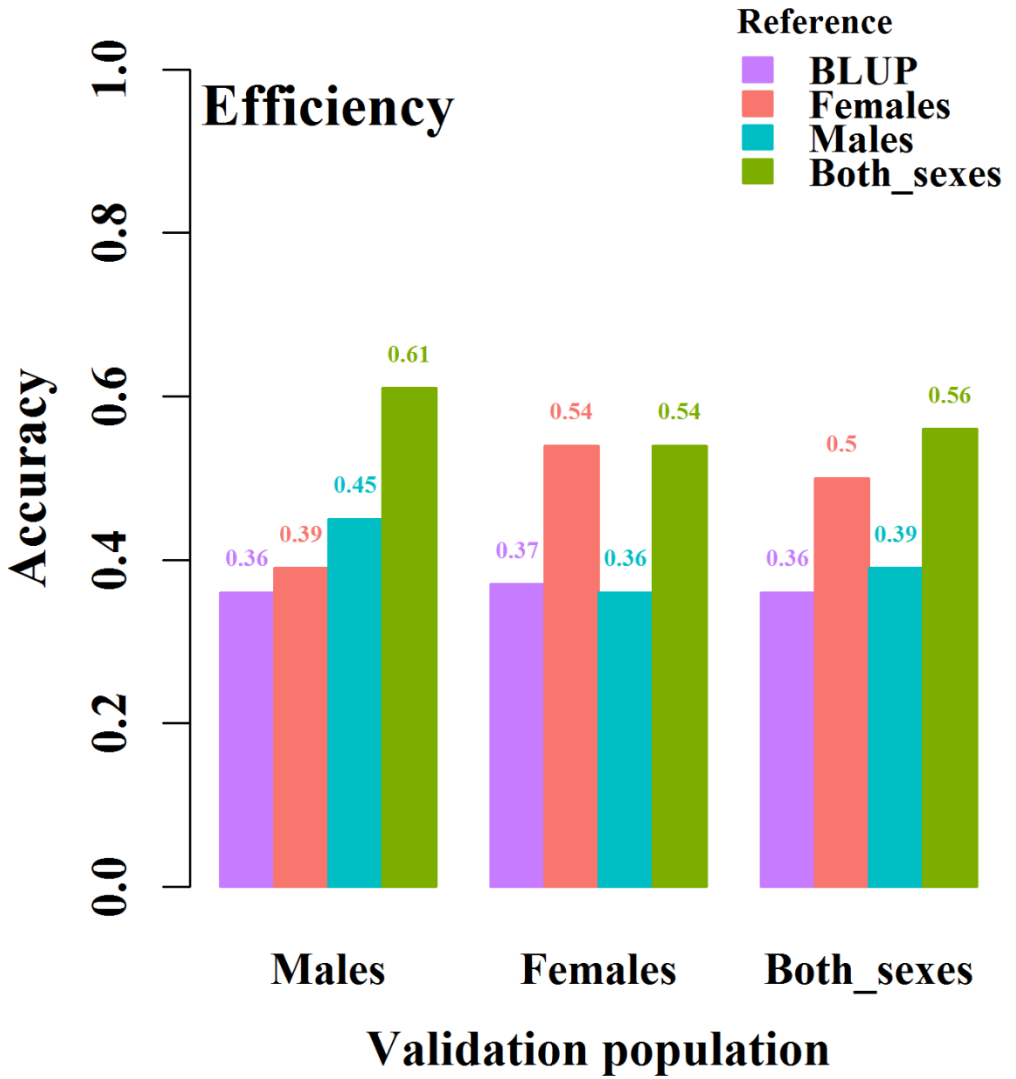
EBV
&
GEBV

$$\text{ACCURACY}_{\text{g16}} = \frac{correlation(y - Xb, [G]EBV)}{h}$$

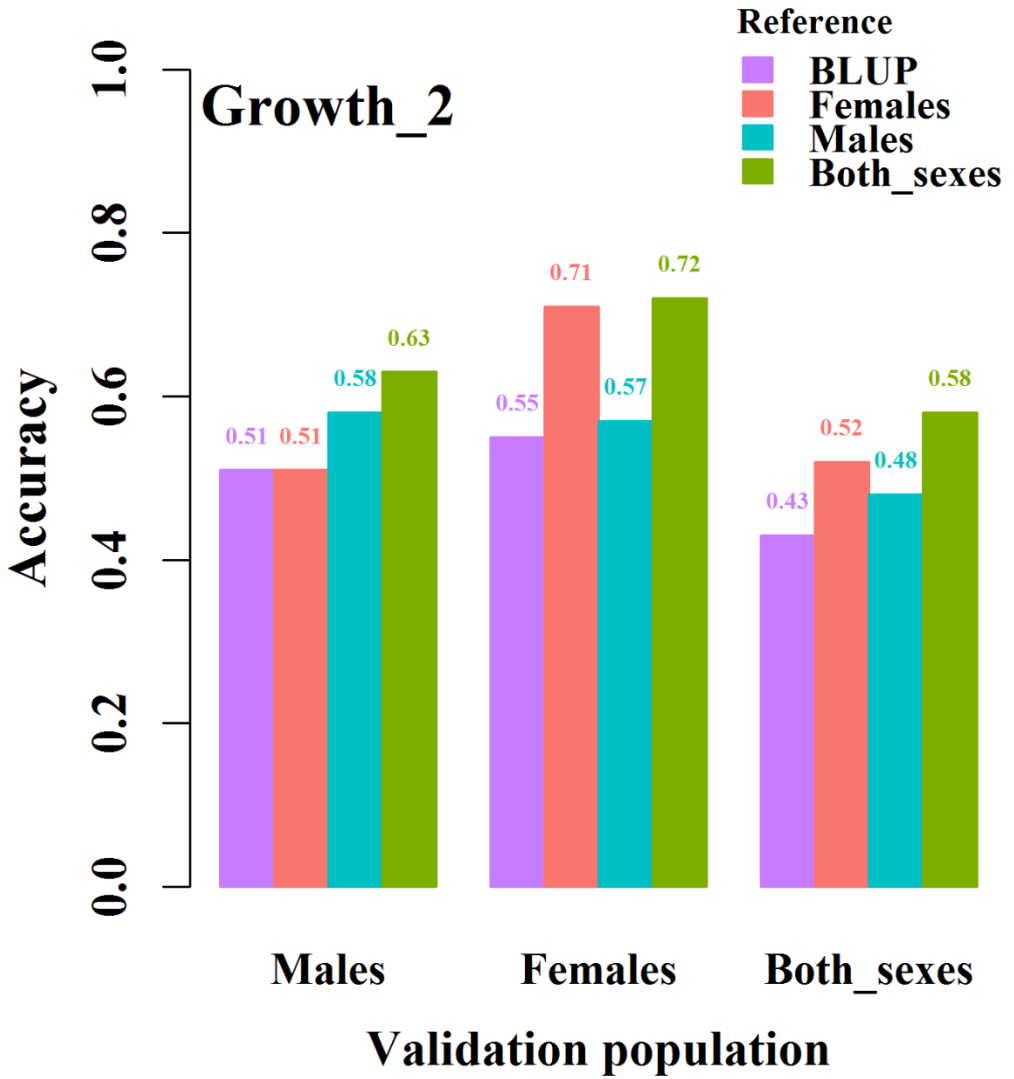
Accuracy for Growth_1



Accuracy for Efficiency



Accuracy for Growth_2



Accuracies for 4 traits

- Overall gain in accuracy of GEBV over EBV

VALIDATION / REFERENCE	Males	Females
Males	**12**	**1**

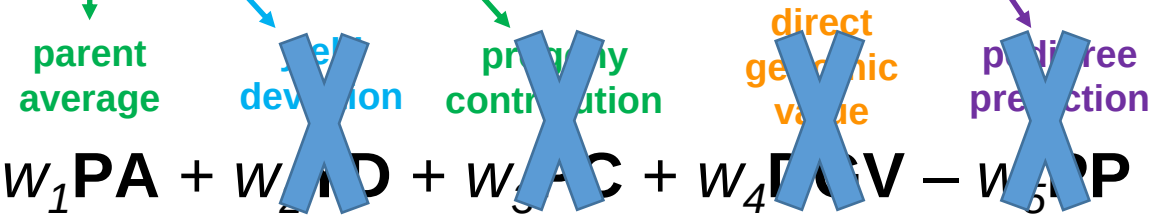
Accuracies for 4 traits

- Different accuracy for males and females
- Is it due to sexual dimorphism?
- Split trait into male and female trait van der Heide et al. 2015

Trait	Genetic correlation	EBV correlation
Growth_1	0.87	0.93
Growth_2	0.91	0.98
Efficiency	0.87	0.94

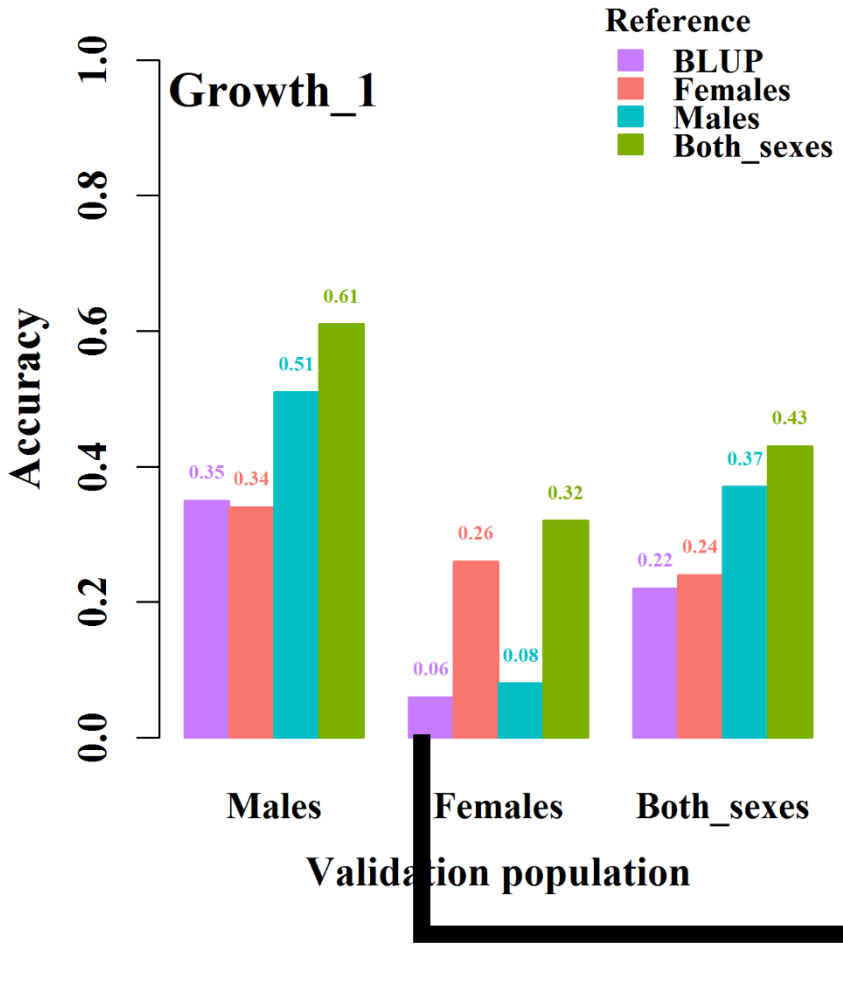
Decomposition of GEBV in ssGBLUP

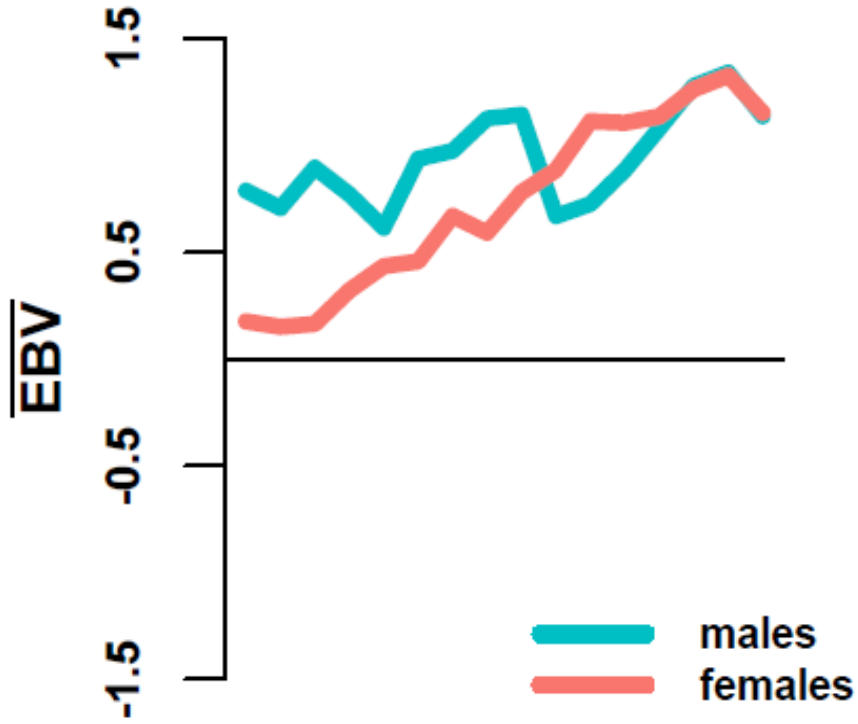
$$\left\{ Z'MZ + aA^{-1} + a\begin{bmatrix} 0 & 0 \\ 0 & G^{-1} - A_{22}^{-1} \end{bmatrix} \right\} \hat{u} = Z'My$$



GEBV = w_1PA + w_2MD + w_3MC + w_4DGV – w_5RP

Accuracies for 4 traits





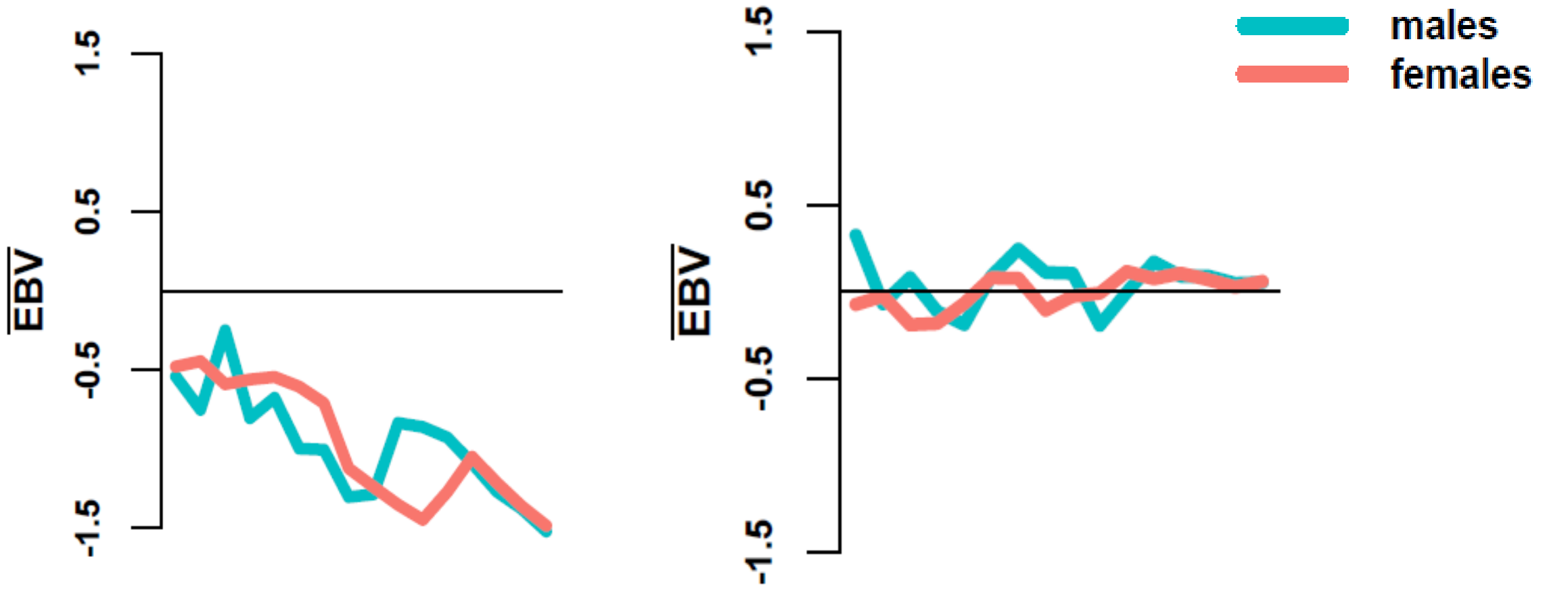
0.06 vs 0.35

Accuracies for 4 traits

$h^2 = 0.25$

$h^2 = 0.22$

= amount of info



Summary

- Advantages of genotyping are mainly for genotyped animals
- Animals from one sex benefit from genotypes on the same sex
- Genotyping females and males is beneficial in broiler chickens
- Selection reduces realized accuracies