



Why breeding values and why international breeding values?

Motivation for a great, though challenging project

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Outline

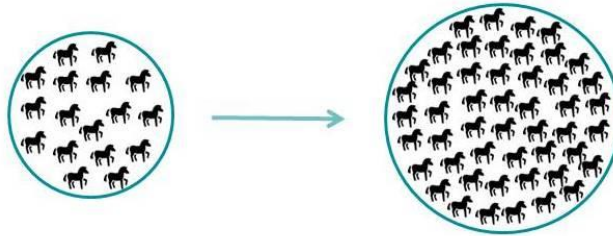
- ❖ **From breeding by eye and sense to breeding values**
 - ◆ basic concepts at a glance
 - ◆ breeding for complex traits
 - ◆ valuable tools for breeders
- ❖ **From breeding values to international breeding values**
 - ◆ rationale behind extending the data basis
 - ◆ reasonable steps to take (examples)
 - ◆ prospects



Breeding? – basic concepts I



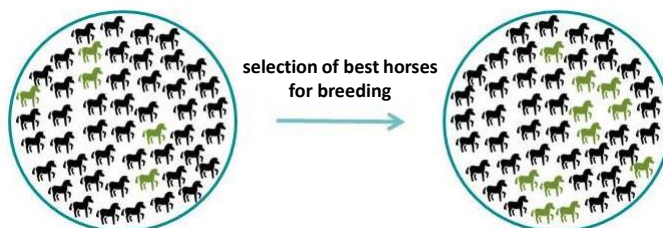
- quantitative aspect:
stabilizing or increasing the population (target number of animals)
→ less relevant in the sport horse



Breeding? – basic concepts II



- quantitative aspect:
stabilizing or increasing the population (target number of animals)
→ less relevant in the sport horse
- qualitative aspect:
improving the population (higher average quality of animals)
→ the driver of sport horse breeding



Breeding → selection?



- What is 'best' from a breeder's point of view?
 - criteria according to the breeding goal
 - genetic quality
 - mares / stallions producing sport horses that are:
successful in competitions, able to perform at high level



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Breeding → selection?



- What is 'best' from a breeder's point of view?
 - criteria according to the breeding goal
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- the challenge for studbooks and individual breeders:
 - **How to select the best horses to become parents?**
or rather
 - **How to find the horses that will produce best offspring?**

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Performance at high level – a complex trait



Breeding for complex traits?



Which horse do you bet money on?
Which horse do you select for breeding?



Breeding for complex traits? – requires data



Which horse do you bet money on?
Which horse do you select for breeding?

No. 2 is younger than No. 4

No. 4 is a mare

No. 4 is trained by an amateur,
No. 2 by a top professional

No. 2 has a really good pedigree
(very successful relatives)



Answering is not so easy!
Different answers may be given
by betters and breeders!

It's a complex topic!



Approaches & tools to tackle complex traits



- 1) Define your target - as precisely as possible.
 - What horse to breed? What specifically to improve?



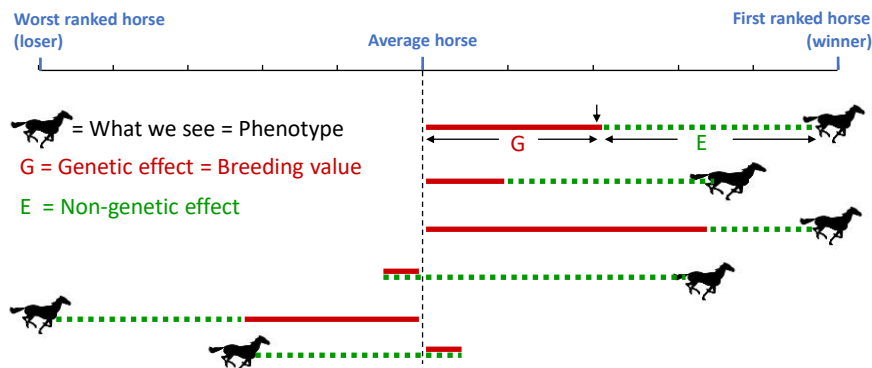
Approaches & tools to tackle complex traits



- 1) Define your target - as precisely as possible.
 - What horse to breed? What specifically to improve?
- 2) Make sure that genetics play a role for what you see (or wish to see).
 - Are genes responsible for what you see and for the variation in what you see?
 - If your target trait is heritable, to which extent?
- 3) Collect data and then try to disentangle: genetic effects vs. non-genetic effects.
 - Which data to use? Which environmental (= non-genetic) influences to consider?
 - Which tools to use?
Own performance and/or simple progeny statistics? – most likely not enough
Breeding values (genetic evaluation)? – supposed to be helpful



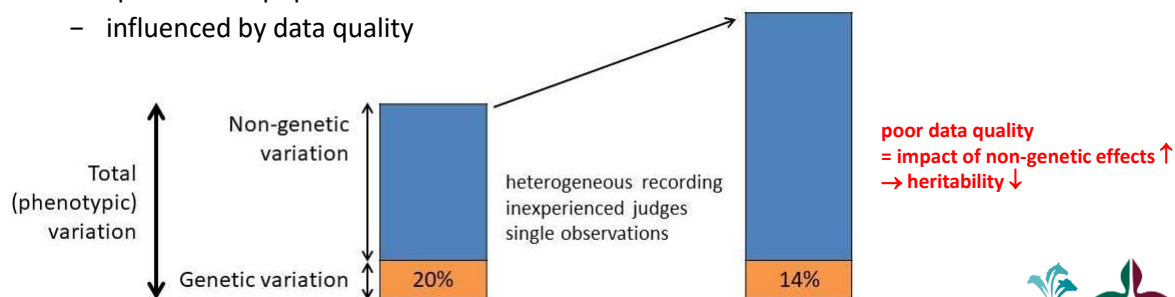
Genetic and non-genetic effects





Most traits are heritable – more or less ...

- heritability = relative importance of genes for a trait (proportion of total variation in a trait that is genetic, so approachable by breeding)
- heritability of some trait is not a constant, but
 - specific for a population
 - influenced by data quality



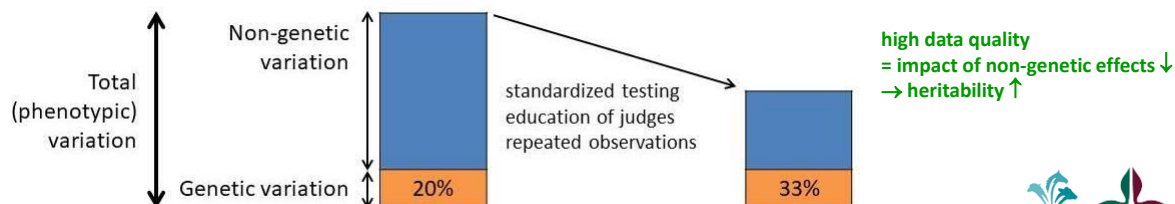
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Heritability & breeding tools



- highly heritable traits
→ good chances to achieve reasonable breeding progress through 'breeding by eye'
- traits of low heritability
→ need for tools to find the best horses not only by chance

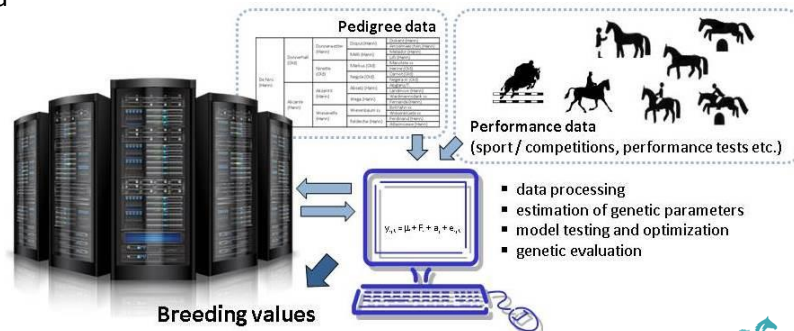
Heritability level	Examples of traits	Amount of data needed	Approach and methodology / tools
high	basic morphology aspects like size (withers height) with $h^2 \approx 0.45-0.55$	+	easy e.g. phenotypes
moderate	conformation traits, some performance traits like certain gait characteristics with $h^2 \approx 0.20-0.35$	++	advanced e.g. breeding values
low	many performance traits, behavior, health traits with $h^2 \approx 0.10$ or less	+++	sophisticated e.g. (genomic) breeding values



Breeding values |



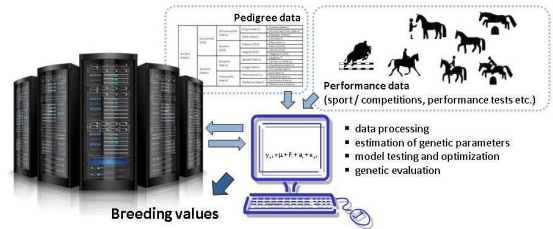
- genetic evaluation (= estimation of breeding values) as way to optimally use all available data in order to find the genetically best horse
 - phenotypic data
 - pedigree data



Breeding values II



- genetic evaluation (= estimation of breeding values) as way to optimally use all available data in order to find the genetically best horse
 - phenotypic data
 - pedigree data
- breeding values are
 - considering information on the horse, all progeny and all further relatives
 - corrected for non-genetic factors
 - reflecting the expected value for breeding (genetic quality) rather than the horse's own performance (phenotypic quality)
 - expressed in relation to a population mean



Why breeding values (BVs)? I



- obvious shortcomings of phenotype based selection (own performance), especially for complex traits



Why breeding values (BVs)? I



- obvious shortcomings of phenotype based selection (own performance), especially for complex traits
- **BVs are a more reliable selection basis**
because all data are used and non-genetic effects are filtered out



Why breeding values (BVs)? II



- obvious shortcomings of phenotype based selection (own performance), especially for complex traits
- **BVs are a more reliable selection basis**
because all data are used and non-genetic effects are filtered out
- clear advantages of using all known pedigree links
- **BVs can separate horses with equal performances**
- **BVs are available for more horses**
(also for relatives without own performance)

	xx	x	

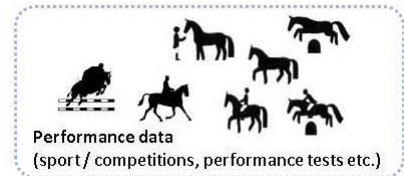
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Why breeding values (BVs)? III



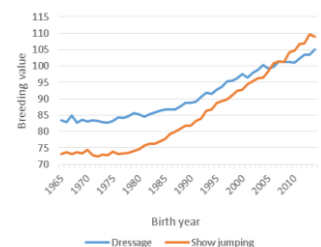
- ...
- breeding programs benefit from improved information basis
- **BVs can integrate information from different data sources**
- **BVs for different traits can be weighted into a total index reflecting the breeding goal**



Why breeding values (BVs)? IV



- ...
- breeding programs benefit from improved information basis
- **BVs can integrate information from different data sources**
- **BVs for different traits can be weighted into a total index reflecting the breeding goal**
- studbooks and breeders benefit from improved transparency
- **BVs make horses population-wide comparable**
- **BVs reflect the genetic trends and by that allow measuring the success of the breeding program**



International breeding values



- integration of data from more than one country
- important for optimal use of results from international competitions (FEI data)
 - 'embedding' to support appropriate interpretation
- challenges related to general requirements for genetic evaluation:
 - clear target definition, standardized data recording
 - comparability of existing traits? harmonized and/or agreed new traits?
 - high (enough) data quality
 - necessary control of non-genetic effects
(causing noise, errors may accumulate and impact results)
 - correct and complete pedigrees
 - Universal Equine Life Number



Comparisons between studbooks (example) |



- pilot study in connection with new applications for linear profiling
- ongoing collaboration between studbooks: Oldenburg (OL, OS) and Swedish Warmblood (SWB)
- use of breeding values of stallions for linear traits

Data structure with reference to figures from the first presentation of study results (prototypes of genetic evaluations in 2016).

Sire group characteristics	Progeny group	No. of linearly described progeny per sire within studbook	
		OL/OS (N _{sires} =1,627)	SWB (N _{sires} =331)
All stallions: linearly described progeny in OL/OS or SWB	foals	7.7 (max. 181) / N _{sires} =864	-
	≥2.5-year-olds	3.4 (max. 101) / N _{sires} =1,114	5.7 (max. 69)
Stallion sample (N=132): linearly described progeny in OL/OS <u>and</u> SWB	foals	18.2 (max. 174) / N _{sires} =87	-
	≥2.5-year-olds	11.9 (max. 101) / N _{sires} =119	4.4 (max. 46)

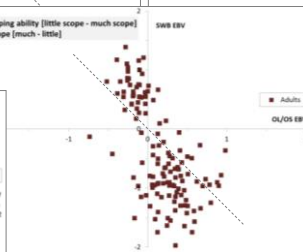
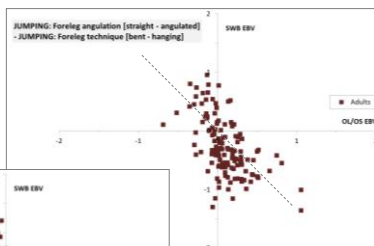
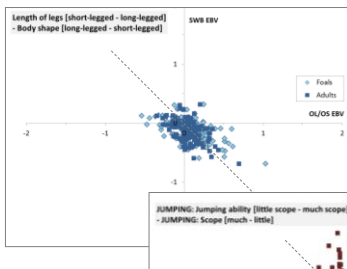
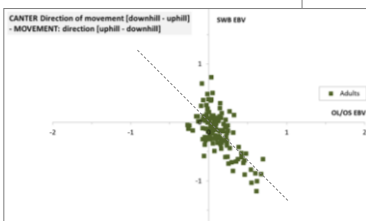
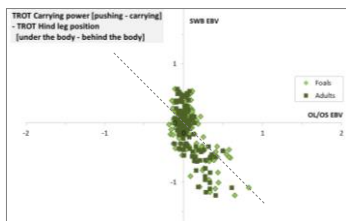


Comparisons between studbooks (example) II



strong support of comparability of important linear traits across studbooks

- several EBV correlations of 0.5 to > 0.7 (despite the still low EBV reliabilities)
- drivers of consistency: similar breeding goals and high motivation to improve phenotypic recording through linear description
- **valuable results for science and practice**



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Why international breeding values (IBVs)? |



- input-output relationship: more data (for the same or very similar trait) increasing reliability of prediction (value of output)
- **IBVs are more reliable thanks to additional information entering the genetic evaluation system**
- **more horses fulfill publication criteria for IBVs than BVs**

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Why international breeding values (IBVs)? II



- input-output relationship: more data (for the same or very similar trait) increasing reliability of prediction (value of output)
- **IBVs are more reliable thanks to additional information entering the genetic evaluation system**
- **more horses fulfill publication criteria for IBVs than BVs**
- pros and cons of internationality of horse trade, sport and breeding
- **IBVs appear straightforward because of shared target traits and pedigree-links across studbooks**
- **IBVs can consider wider (more realistic) ranges of progeny**
- **IBVs can promote optimum use of performance at highest level**



Why international breeding values (IBVs)? III



- ...
- studbooks and breeders benefit from further improved transparency
- **IBVs make horses comparable across studbooks (IBVs help finding the 'best' horse for breeding on a global scale)**
- **IBVs support breeding progress in each participating studbook**
- **IBVs allow measuring the success of breeding programs and of sport horse breeding**



Prospects



- great potential of international breeding values for WBFSH member studbooks and for sport horse breeding as a whole
- clearly defined tasks
 - different starting points, but options to work towards IBVs for all studbooks

What is needed?

- **well defined target** – what do we want to achieve?
- **systematic and high quality data recording**
 - traits reflecting the breeding goal
 - standardized recording
 - many horses, representative for the population
- **correct and complete pedigree data**
- **reliable infrastructure:** geneticists and computers 😊

Thank you!

- **challenges of the IBV project to be met by collaboration making best use of available resources and expertise**