INTRODUCTION TO

ANIMAL BREEDING

Lecture Nr 3

The genetic evaluation (for a single trait)

The Estimated Breeding Values (EBV)

The accuracy of EBVs

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Purpose and general approach

How to deal with the environmental factors

The Estimated Breeding Values

The accuracy of EBVs

Summary

On what to select a reproducing animal

A/ ~~On the basis of its own performance~~

B/ On the basis of the expected value of its offspring

How to rank the candidates
on the basis of the value of their future offspring?

On the basis of their additive genetic value

Concept of additive genetic value

(Reminder)

$$P = \mu + G + E \qquad G = A + D$$

Sum of the vaerage gene effects

$$\mathrm{E}(A_i \mid A_p) = 1/2\, A_p$$

$$\mathrm{E}(P_i \mid A_p) = \mu + 1/2\, A_p$$

Interaction effects between genes
depend on the way of mating

Previous chapter

Genetic evaluation

To predict (to estimate)
the (additive) genetic value
of a given animal or of a group of animals

Provides the ranking
of candidates to be selected

Estimated Breeding Value

Selection Index

Available information for the genetic evaluation of a given animal

Its own performance(s)

Its genotype for known genes or marker genes

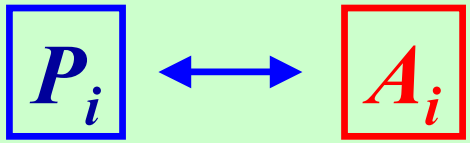
Its pedigree → Performance(s) of Related animals

Basis of genetic evaluation

Importance the data recording

Why performances are useful?

Statistical approach:
The genetic value (A) is a random variable
One looks to predict this value for any animal

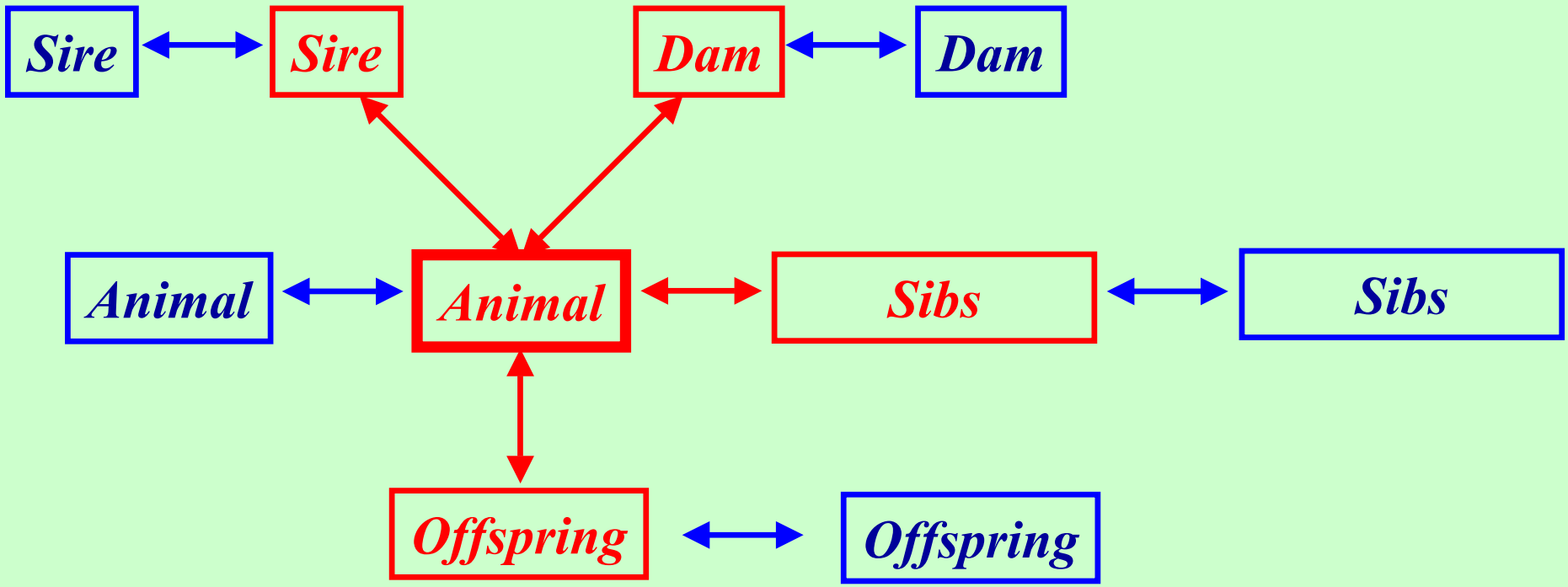


correlation

P_i provides information, due to its correlation with A_i

In that case, correlation is due to the fact that A_i is included in P_i

Why performances are useful?



Due to kinship

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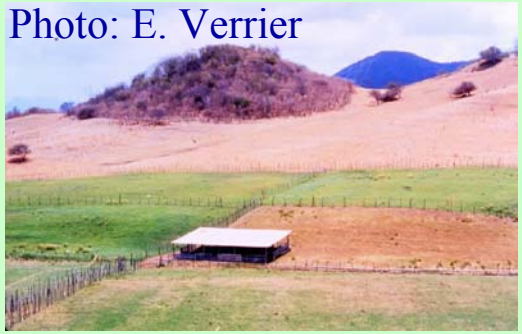
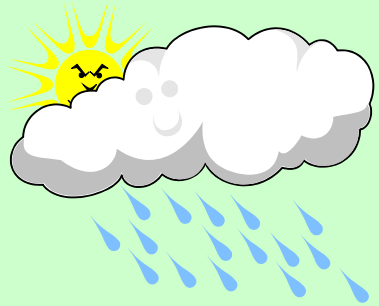
Identified environmental factors



Farm



Year

Season within a year
Primiparous *vs.* multiparous females
Sex (e.g. for growth performances)
etc.

Prior control of the environment

Principle:
To round up all candidates
in the same place at the same time

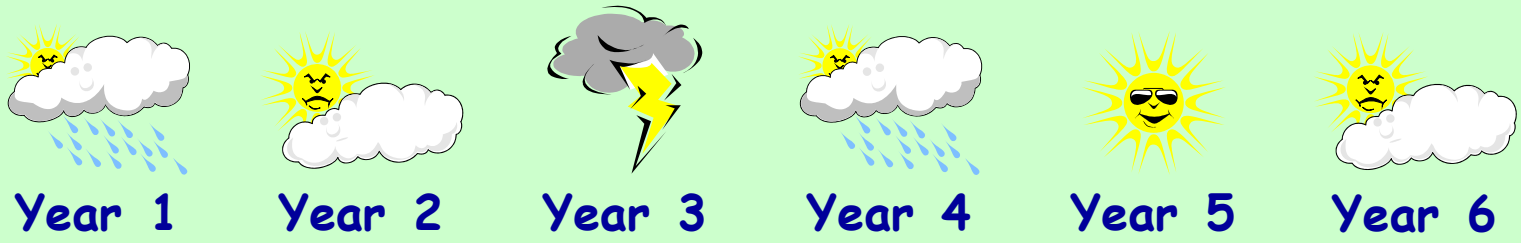
→ Performance control station

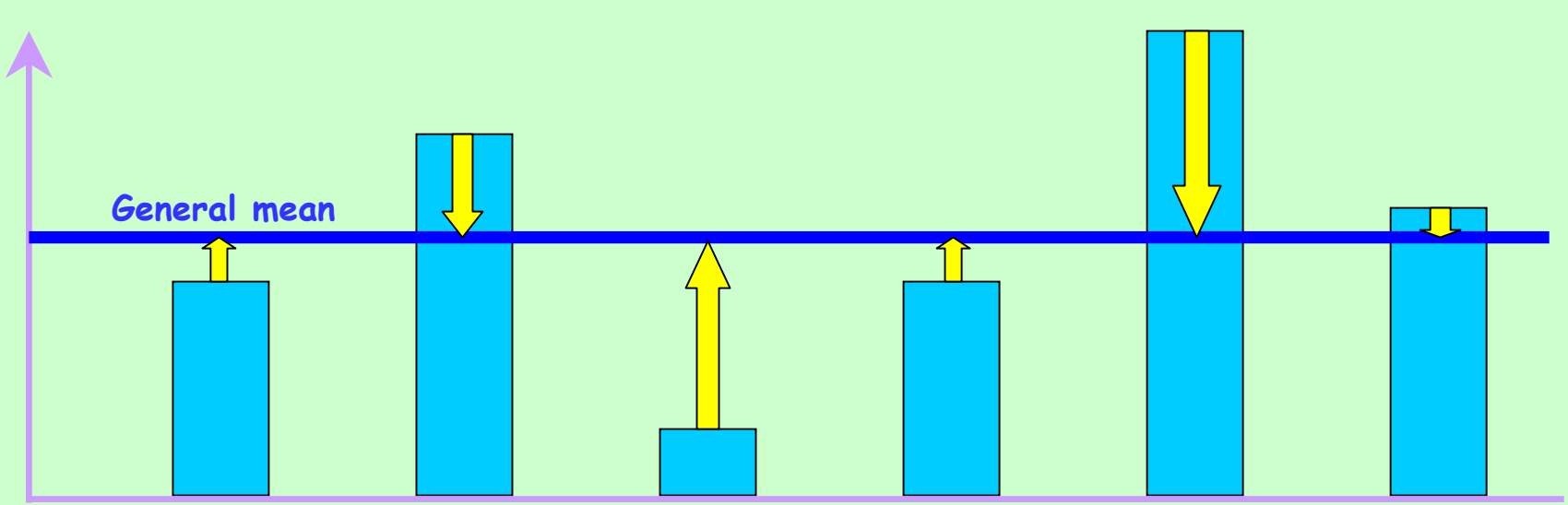
Advantage:
Contemporary animals under homogenous conditions
→ Restriction of the variations due to the environment

Caution:
The environmental conditions within the station should be not too much different from the conditions on farm

Posterior correction of data for the environmental effects: principle

To express all performances as a deviation from a common basis





Posterior correction of data for the environmental effects: practice

Problem not so simple

→ BLUP methodology

Best Linear Unbiased Predictor

→ BLUP EBVs

Animal model BLUP EBVs

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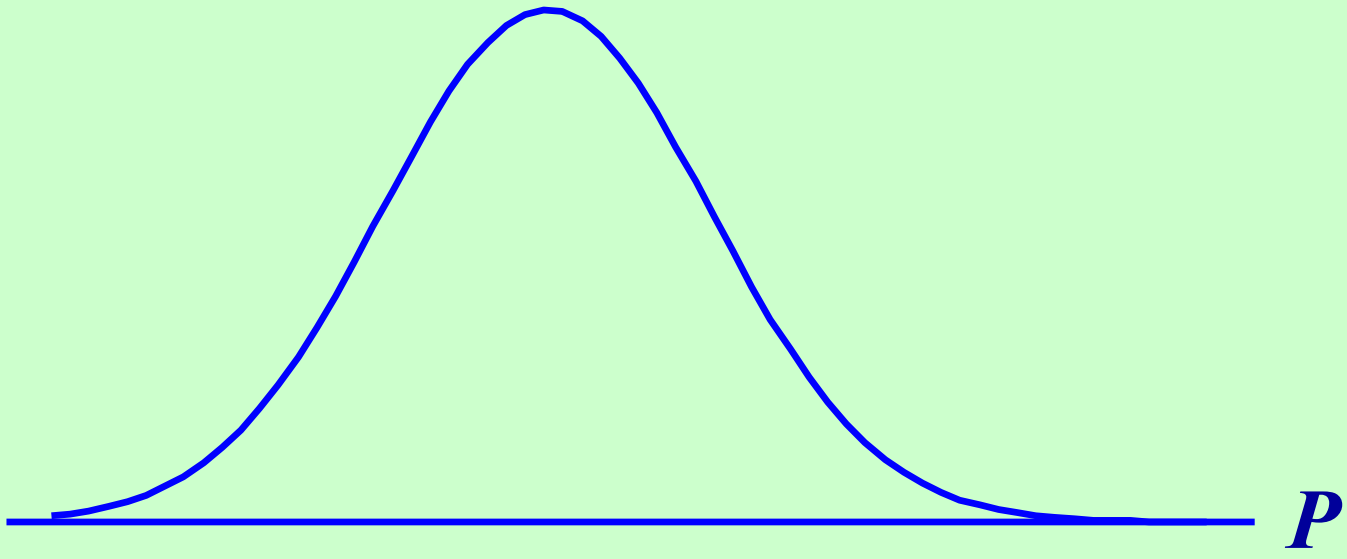
A simple example

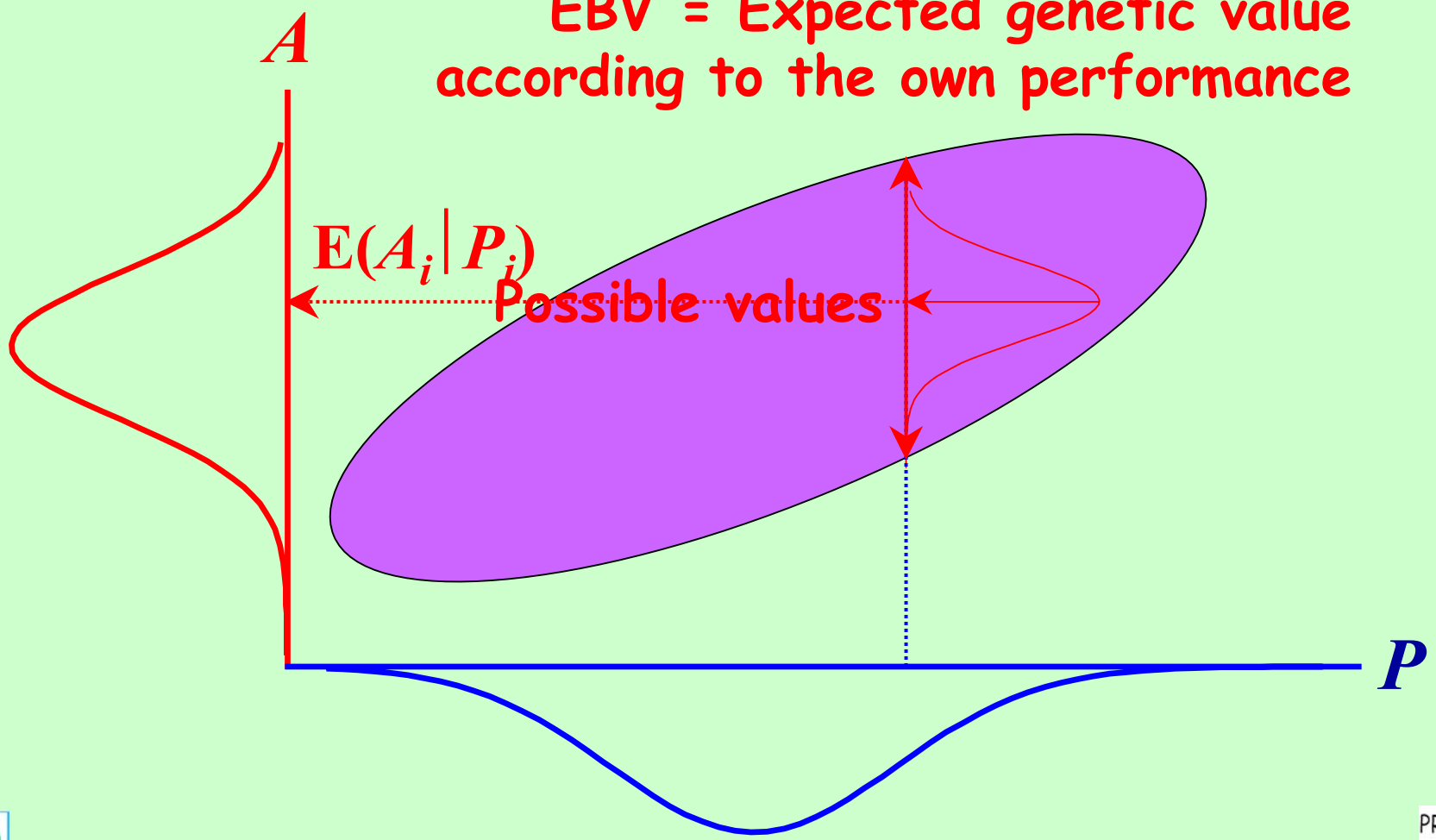
Evaluation on the basis of the own performance



A simple example

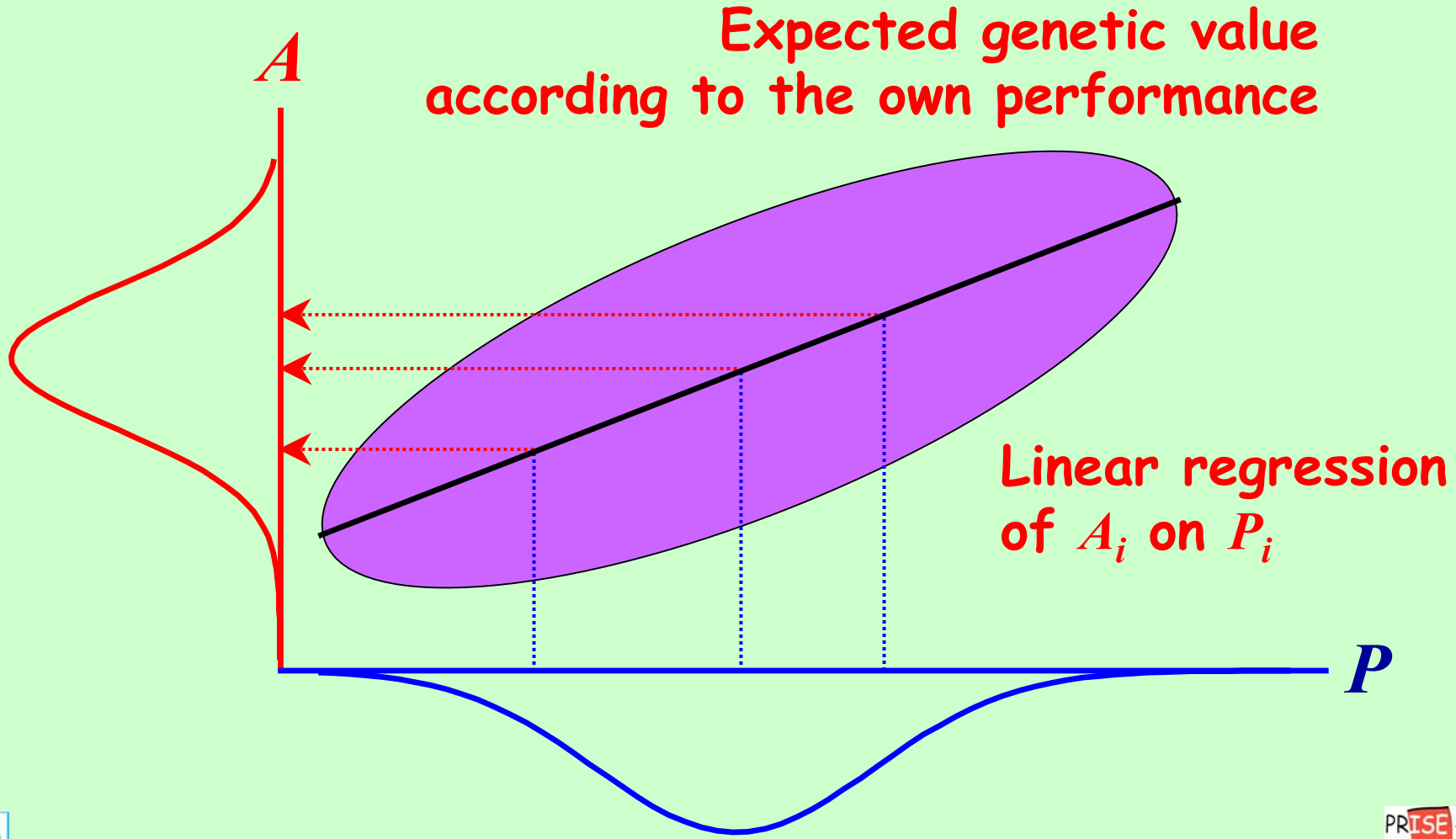
Evaluation on the basis of the own performance

EBV = Expected genetic value according to the own performance



A simple example

Evaluation on the basis of the own performance



EBV : definition

Estimated Breeding Value

=

Conditionnal expected (additive) genetic value

according to the known performance

=

$$b \times (P - \mu)$$

Coefficient of regression of A on P

Case of the own performance

$$b = \frac{\text{Cov}(A_i, P_i)}{\text{Var}(P_i)}$$

$$\text{Cov}(A_i, P_i) = \text{Cov}(A_i, A_i + D_i + E_i) = \text{Cov}(A_i, A_i) = \text{Var}(A_i)$$

$$b = \frac{V_A}{V_P} = h^2$$

$$\text{EBV} = h^2 (P_i - \mu)$$

Reminder : h^2 = proportion of individual differences which is from additive genetic origin

EBV computed on the basis of the performance of a related animal

$$EBV = b\ (P_j - \mu)$$

$$b = \frac{Cov\ (A_i\ ,\ P_j)}{Var\ (P_j)}$$

$Cov\ (A_i\ ,\ P_j) = 2\ \Phi_{ij}\ V_A$

$2\ \Phi_{ij}\ V_A$ = Covariance between relatives

$Var\ (P_j) = f(V_P)$

Previous chapter

Schematic presentation

$$EBV = c \times f(h^2) \times (P - \mu)$$

Weight puted on the available performance

Depends on the difference of generation with the candidate to be evaluated

- Sire's or dam's performance $\rightarrow$ $c = ½$
- Own or sib's performance $\rightarrow$ $c = 1$
- Offspring's performance $\rightarrow$ $c = 2$

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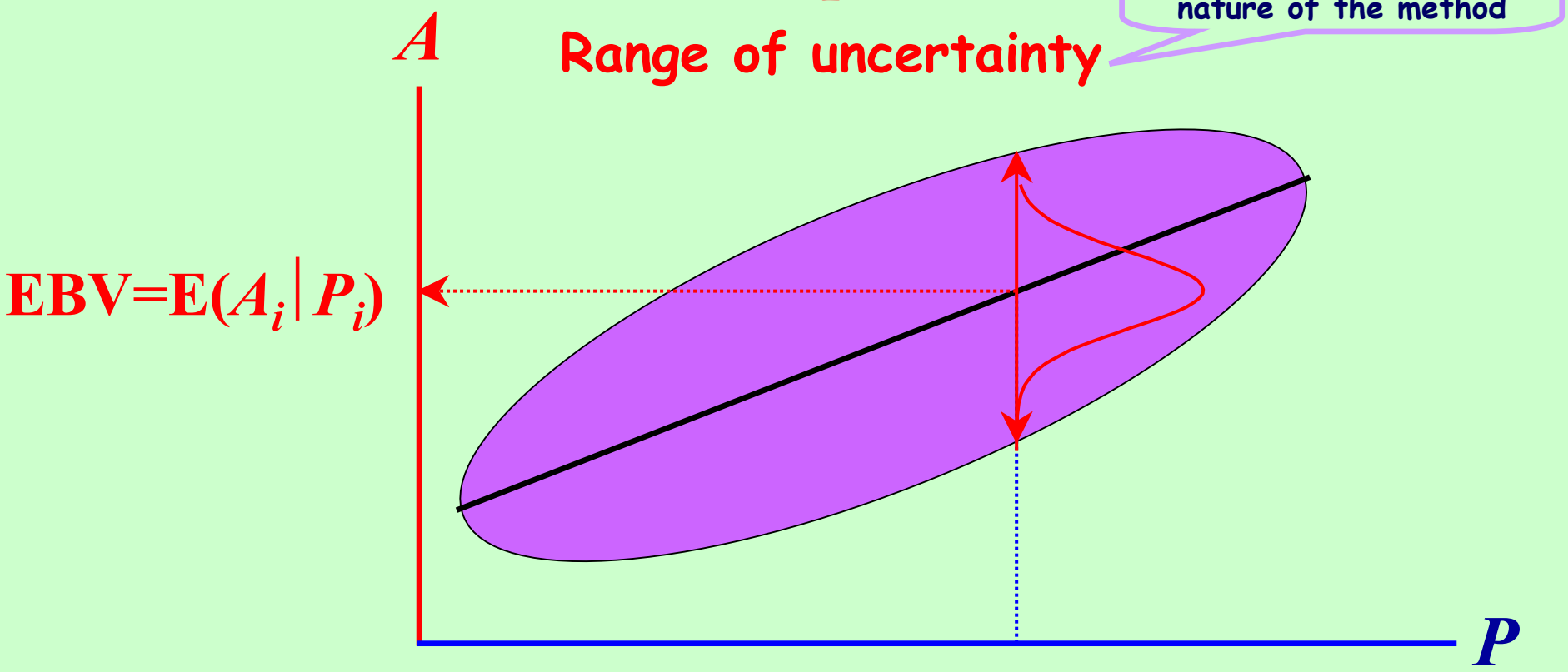
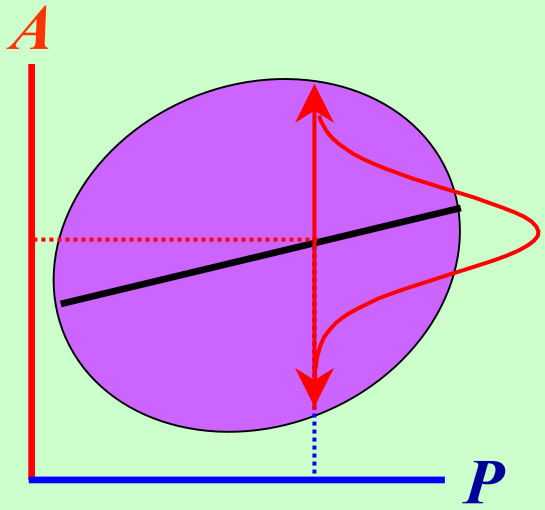
Prediction is not certainty

Possible values
=
Range of uncertainty

It is minimised, by the nature of the method

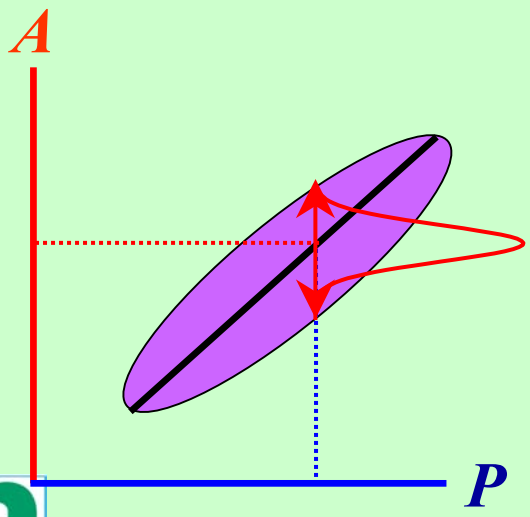


Range of uncertainty
(Variance of prediction error)



Large uncertainty

Low accuracy of the EBV



Small uncertainty

High accuracy of the EBV

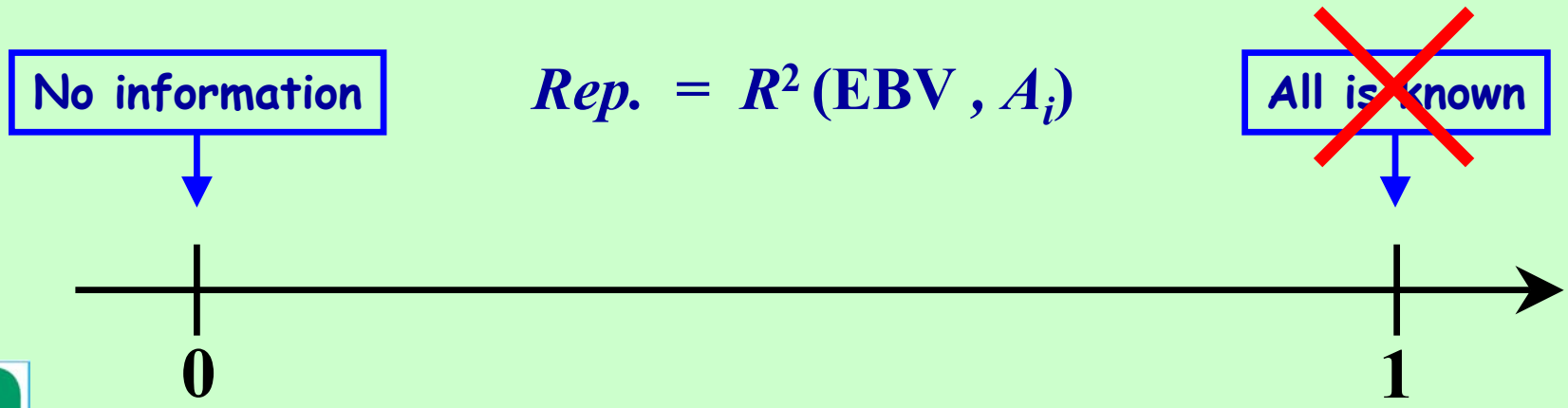
Repeatability (Rep.) / Accuracy

- *C D* -

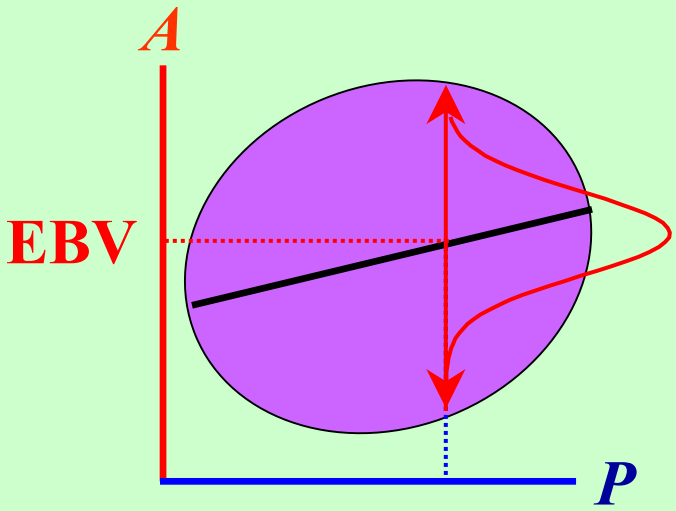
Degree of confidence to be attached to the EBV

An increase of Rep. means that uncertainty is reduced

Square of the coefficient of correlation
between the true genetic value and the EBV



Variance of prediction error



$$\mathrm{E}\left(A\middle|\mathrm{EBV}\right) = \mathrm{EBV}$$

Unbiased predictor

Variance of prediction error (which was minimised):

$$\mathrm{var}(\mathrm{error}) = \mathrm{var}\left(A\middle|\mathrm{EBV}\right) = (1 - \mathrm{Rep})\sigma_A^2$$

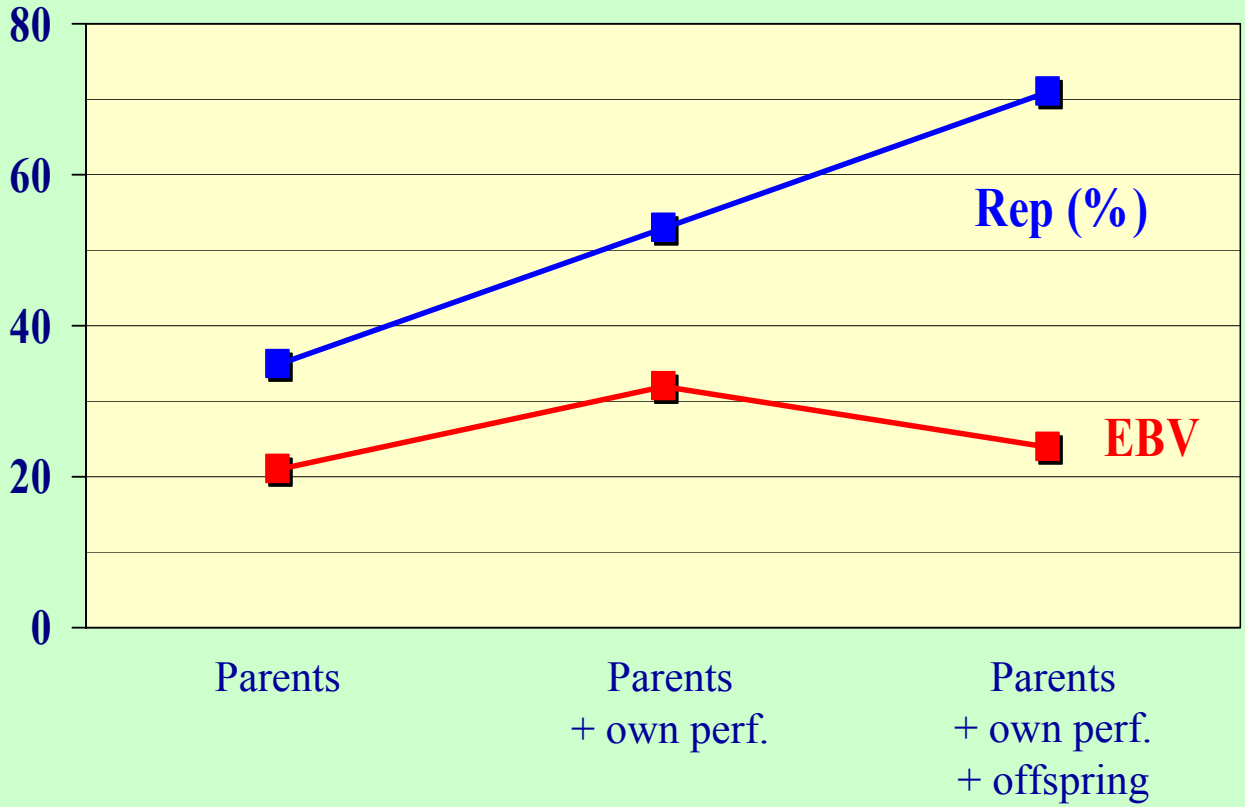
Factors of variation of *Rep*

- The heritability (h^2) of the trait
- The kind and the amount of information taken into account
  - Kind of performance : own or relative's performance
  - Number of performances
  - Correlations between the different performances

Evolution of the EBV and its accuracy during the life of a given animal

The example of a *Selle Français* stallion

Source: Haras Nationaux / INRA



Summary

EBVs are computed from know performances and pedigree data, within a model

Need to take into account the environmental factors

EBV = best predictor of the genetic value

The variance of prediction error can be derived from the accuracy, which depends on the heritability of the trait and on the nature and amount of information