EAAP 2009 – Barcelona – Session 19

Ranking in competition: an efficient tool to measure aptitude ?

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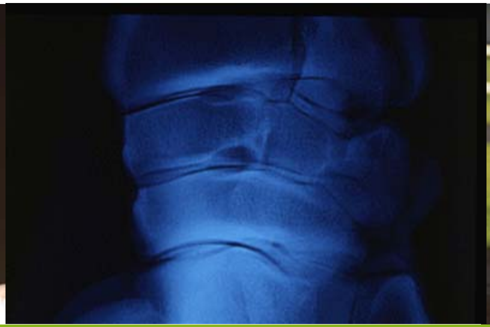

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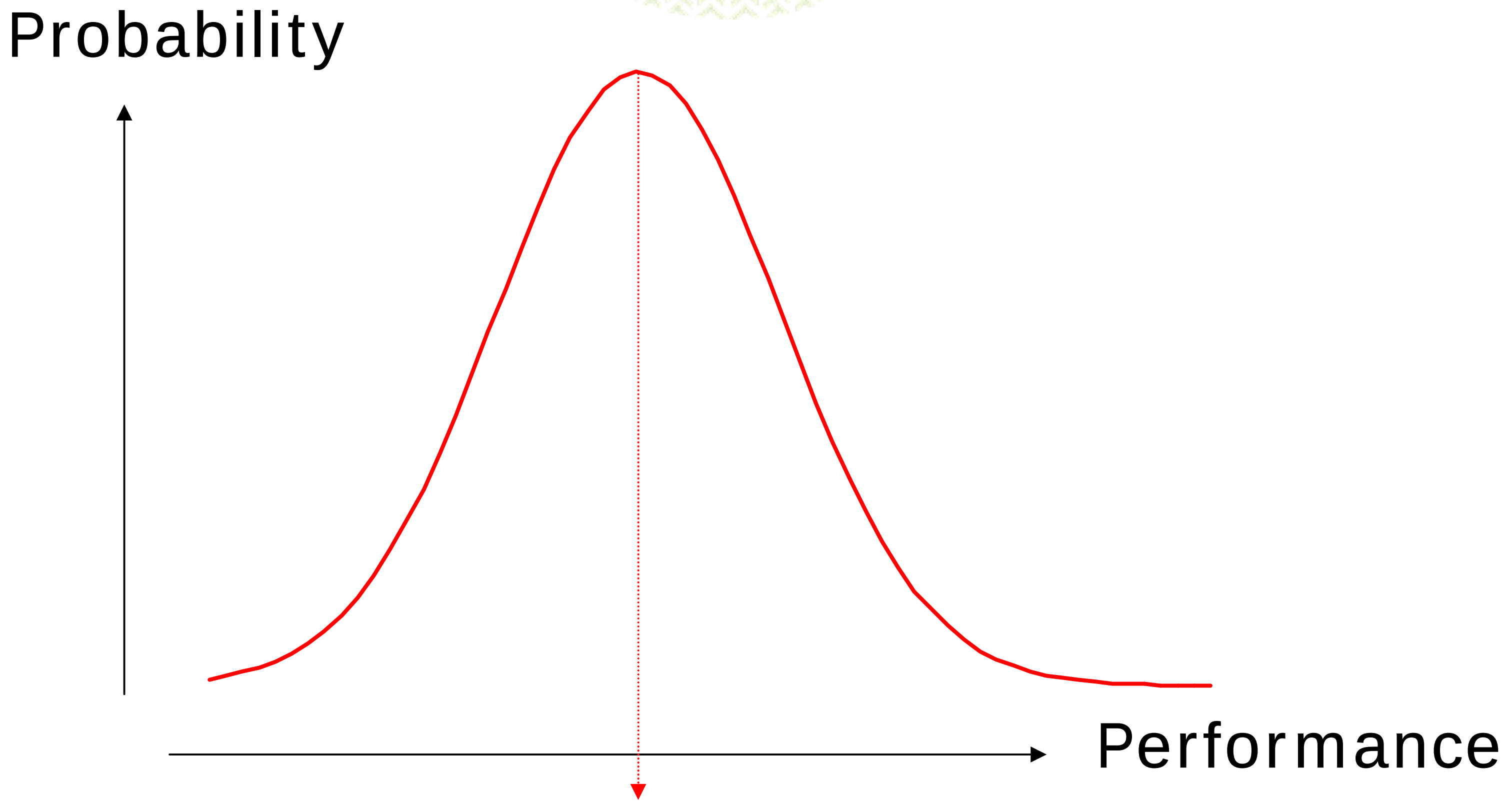
Objective : Validation of ranking model through simulations

Tavernier (1990) proposed an underlying model responsible for ranking in competition, Gianola and Simianer (2006) proposed a full Bayesian analysis of such model (called Thurstonian model).

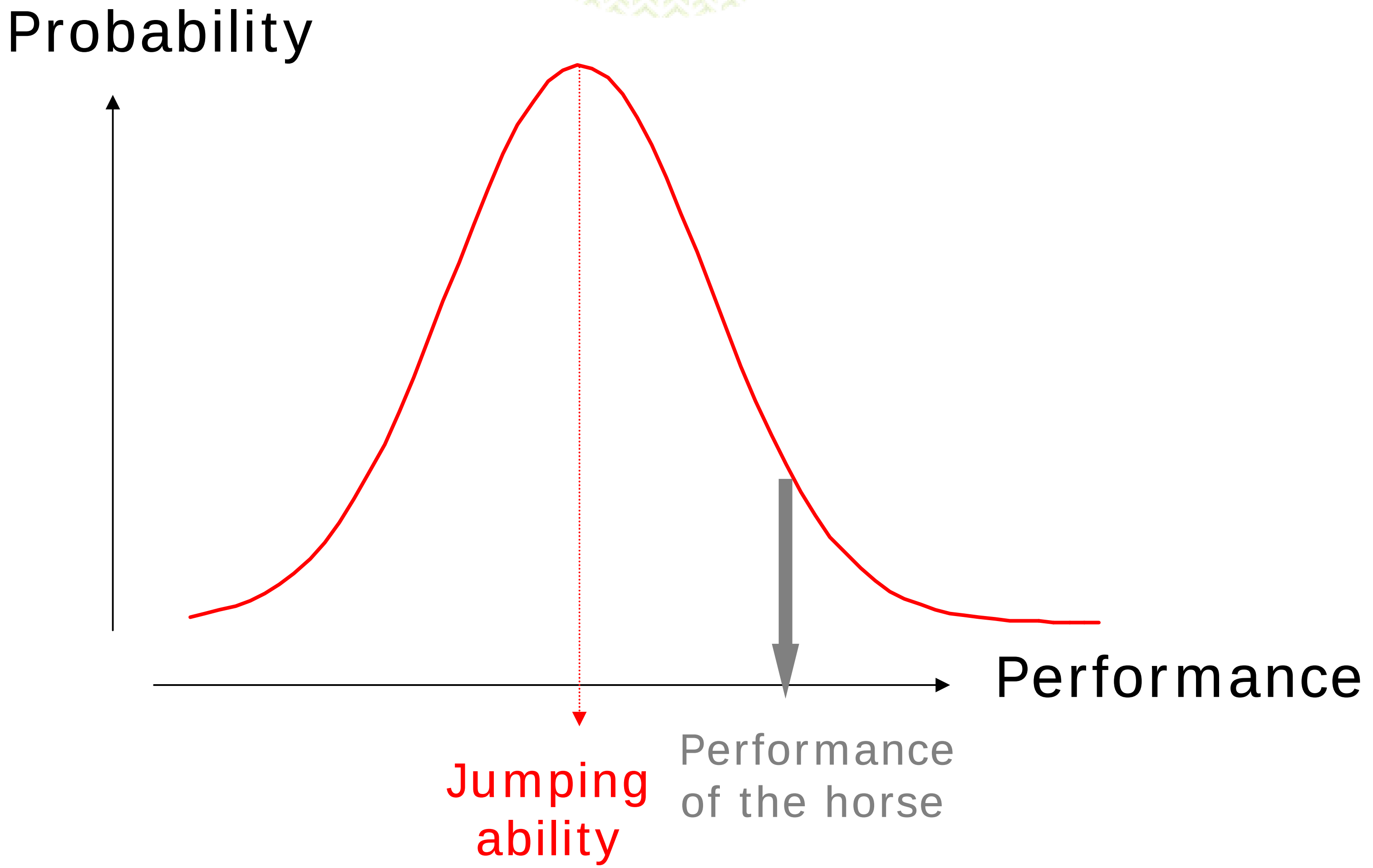
The objective of this paper was to validate these theoretical propositions through simulations in unstructured and structured competitions (different technical difficulty levels)

Ranking Model

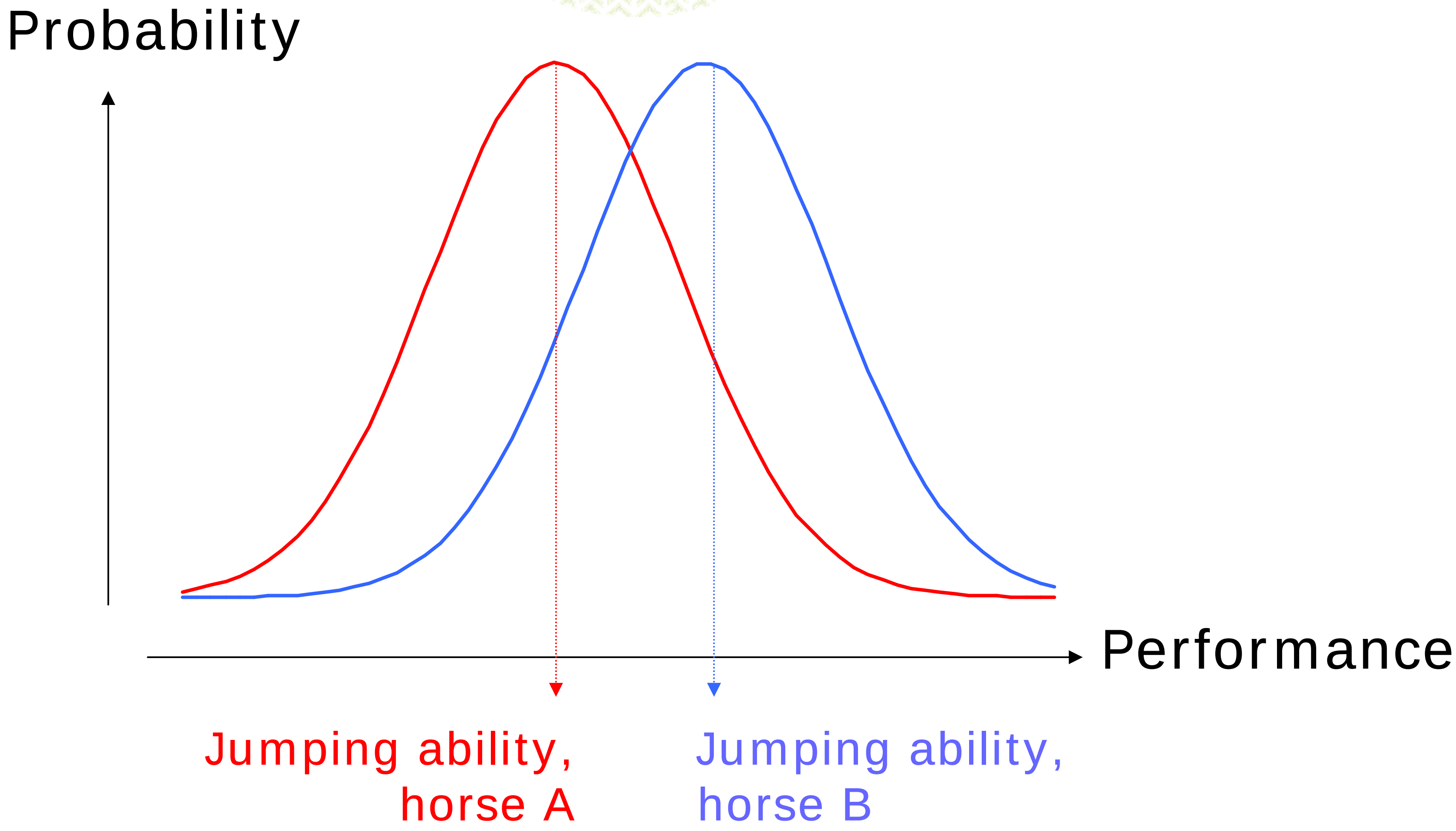


Jumping ability of the horse
(genetic + permanent environment +fixed effects)

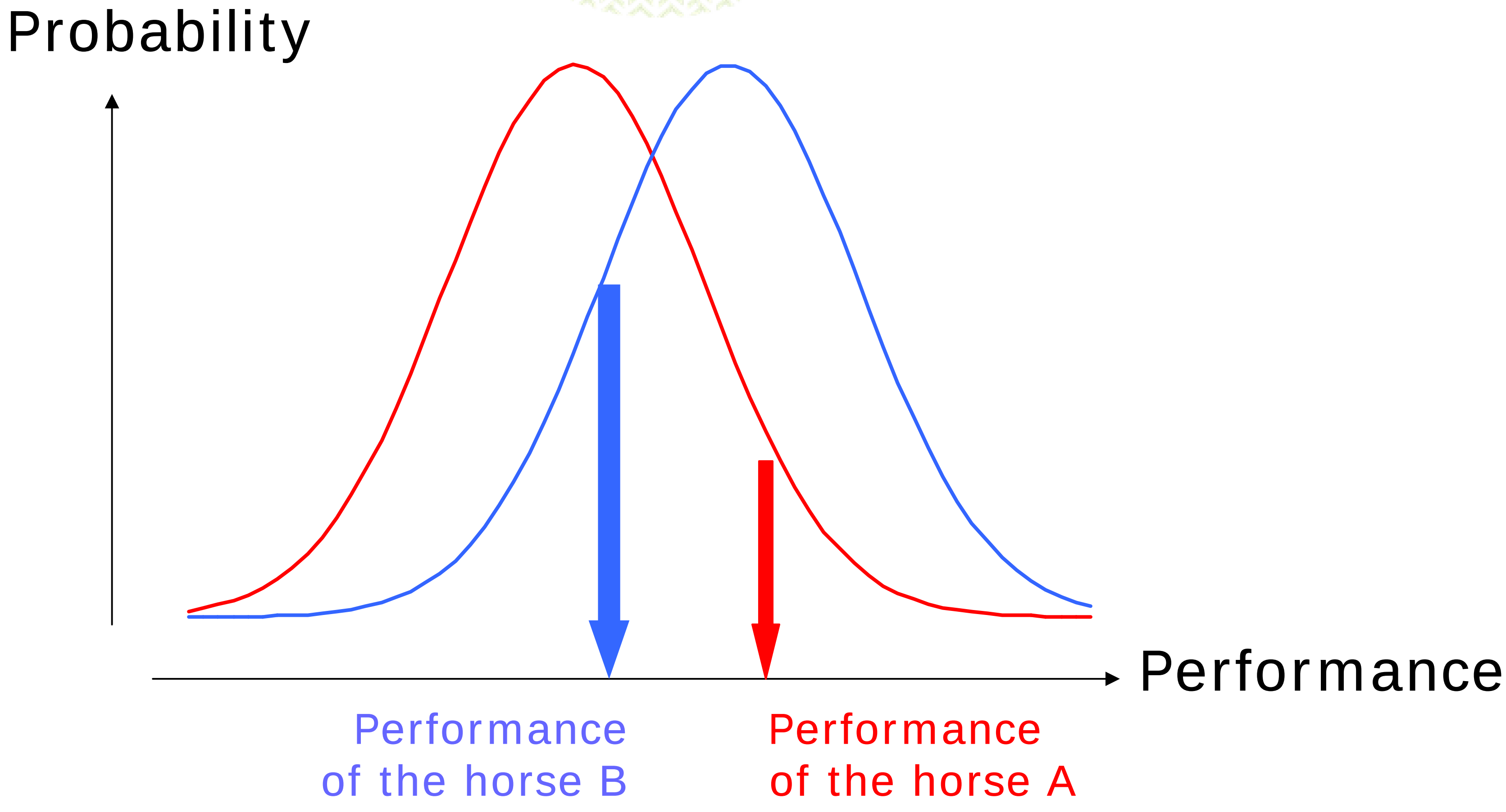
Ranking Model



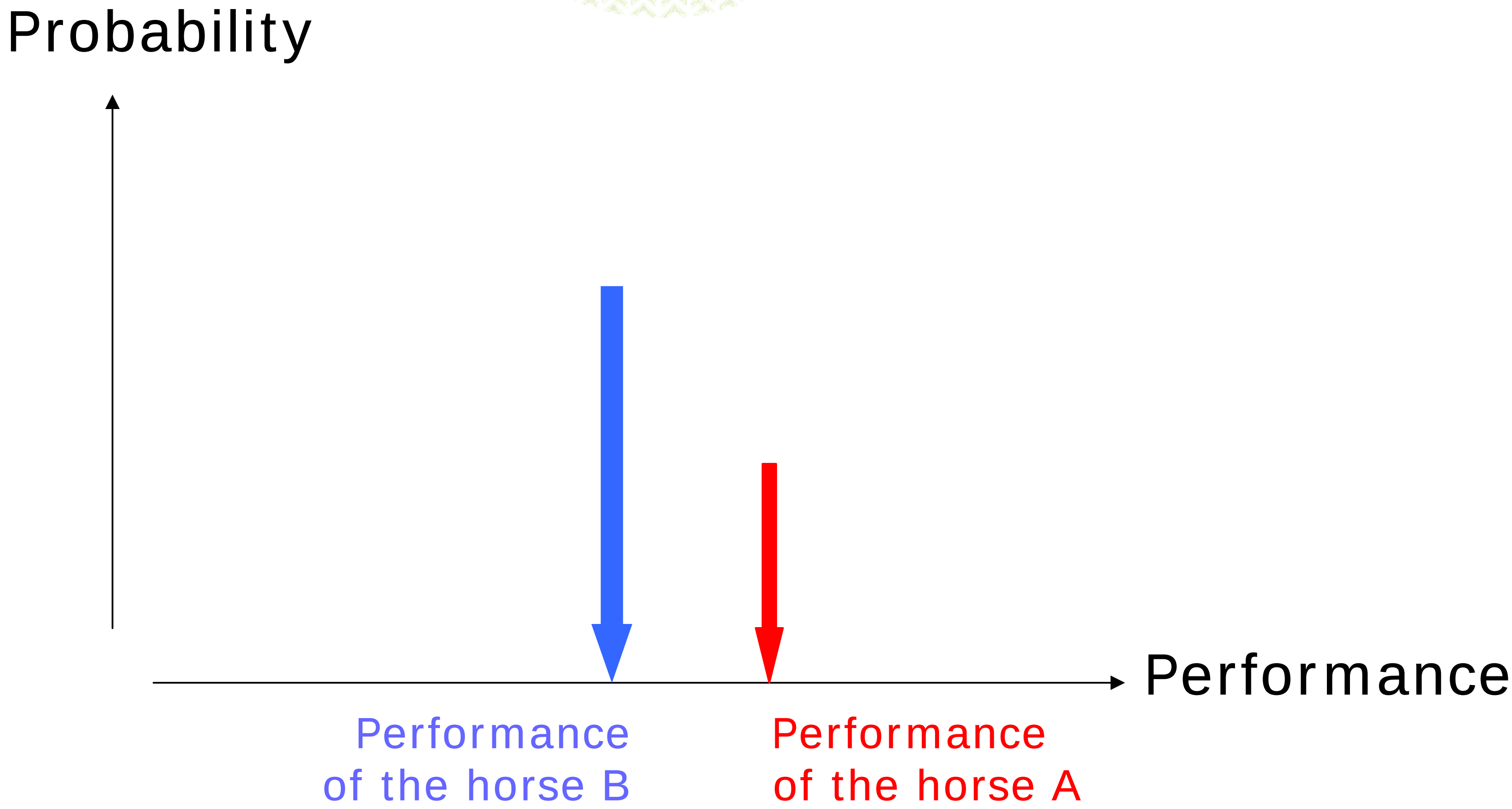
Ranking Model



Ranking Model

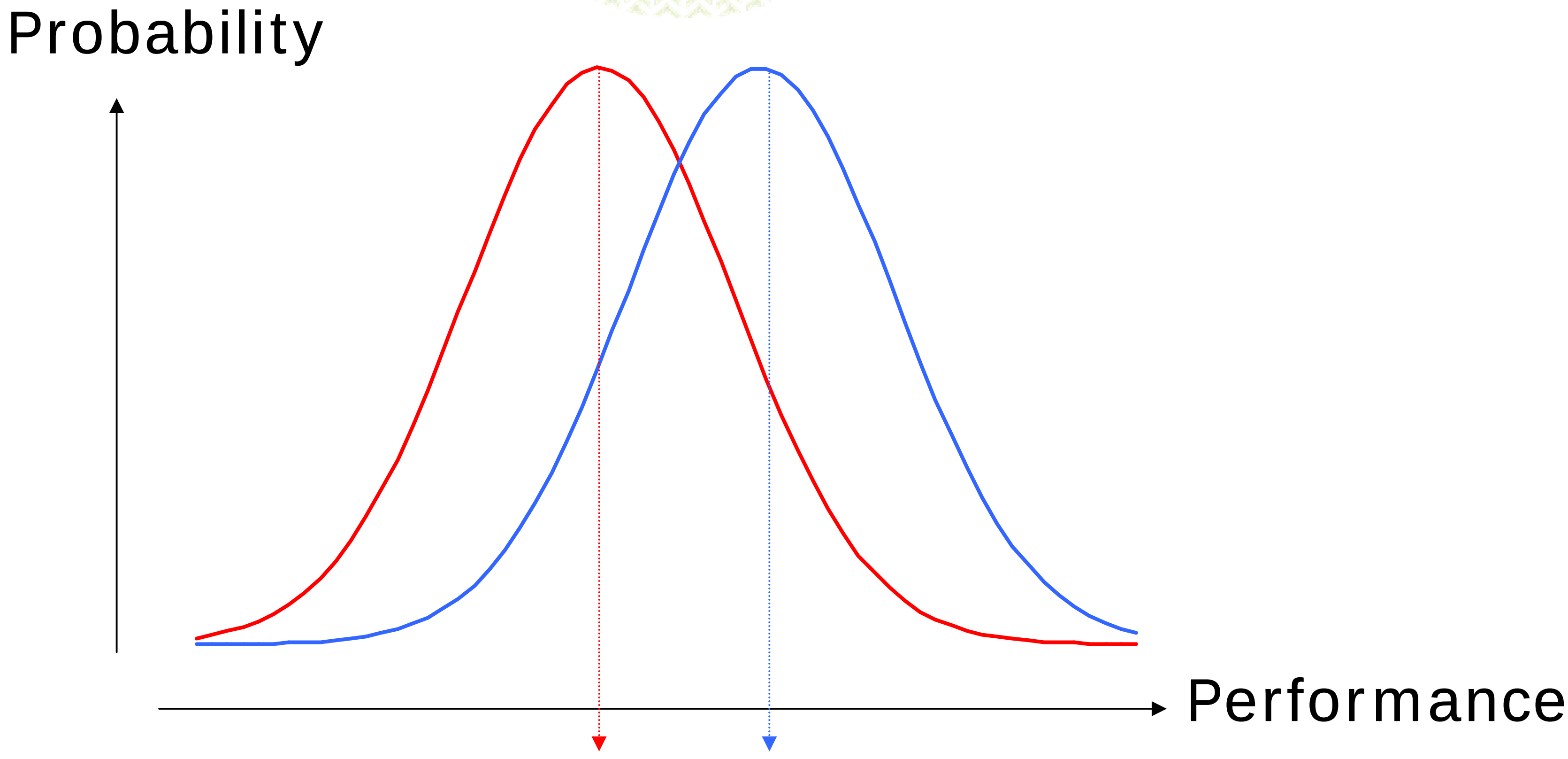


Ranking Model



Ranking : A > B

Ranking Model



Ranking : A > B

Model

underlying performance horse *i* event *r*

$$l_{ir} = \mathbf{x}_{\mathbf{ir}}^{'}\boldsymbol{\beta} + \mathbf{z}_{\mathbf{ir}}^{'}\mathbf{a} + \mathbf{z}_{\mathbf{ir}}^{'}\mathbf{p} + e_{ir}$$

Fixed effects | Random genetic effect | Random permanent environmental effect

μ_{ir}

Conditional Probability of a ranking in an event

$$P(y_r = (1,\cdots,n)' \,|\, \beta, a, p) = \int_{-\infty}^{+\infty}\int_{l_{(n)}}^{+\infty}\ldots\int_{l_{(3)}}^{+\infty}\int_{l_{(2)}}^{+\infty}\prod_{i=1}^{n}\varphi(l_{(i)} - \mu_{(i)})\,dl_{(i)}$$

Method

- Bayesian analysis – Gibbs sampler
- Particular algorithm to draw underlying performances according to ranking

Simulations

- 1000 horses
- Simple model : competing ability=genetic + permanent, no relationship matrix

$$repeatability = \frac{\sigma_a^2 + \sigma_p^2}{\sigma_l^2}$$

- From 10 to 40 ranks/horse and 4 to 20 horses/event
- Unstructured competition: horses met at random
- Structured competition: horses met preferably their peers in event labeled with level of competition (3 levels)

Results unstructured competition

Simulated repeatability : 0.25		
Events/horse	10	10
Horses/event	10	5/10/20
Total ranks	10000	10000
True underlying performance		
Ranking+Underlying model		
Normal score		
Raw ranks		

Results unstructured competition

Simulated repeatability : 0.25		
Events/horse	10	10
Horses/event	10	5/10/20
Total ranks	10000	10000
True underlying performance	0.245	0.251
Ranking+Underlying model	0.243	0.247
Normal score	0.193	0.196
Raw ranks	0.190	0.108

Results unstructured competition

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Results

- Gibbs sampling and underlying model for ranking performed well

- As for discrete variables, use of measurements attributed to ranking (normal score, raw ranks) rather than underlying model gave underestimation of true repeatability (... heritability)

Results: structured competition

Simulated repeatability : 0.25

True underlying performance	0.254
Normal score	0.147
Normal score multiple trait 1	0.186
Normal score multiple trait 2	0.148
Normal score multiple trait 3	0.155
Ranking+Underlying model	0.200

Results: structured competition

Simulated repeatability : 0.25	
True underlying performance	0.254
Normal score	0.147
Normal score multiple trait 1	0.186
Normal score multiple trait 2	0.148
Normal score multiple trait 3	0.155
Ranking+Underlying model	0.200

Results: structured competition

Simulated repeatability : 0.25	
True underlying performance	0.254
Normal score	0.147
Normal score multiple trait 1	0.186
Normal score multiple trait 2	0.148
Normal score multiple trait 3	0.155
Ranking+Underlying model	0.200

Results

- All models underestimate repeatability, ranking with underlying performance in a lower extend

- How to take into account technical level of the competition ?

The « event » effect

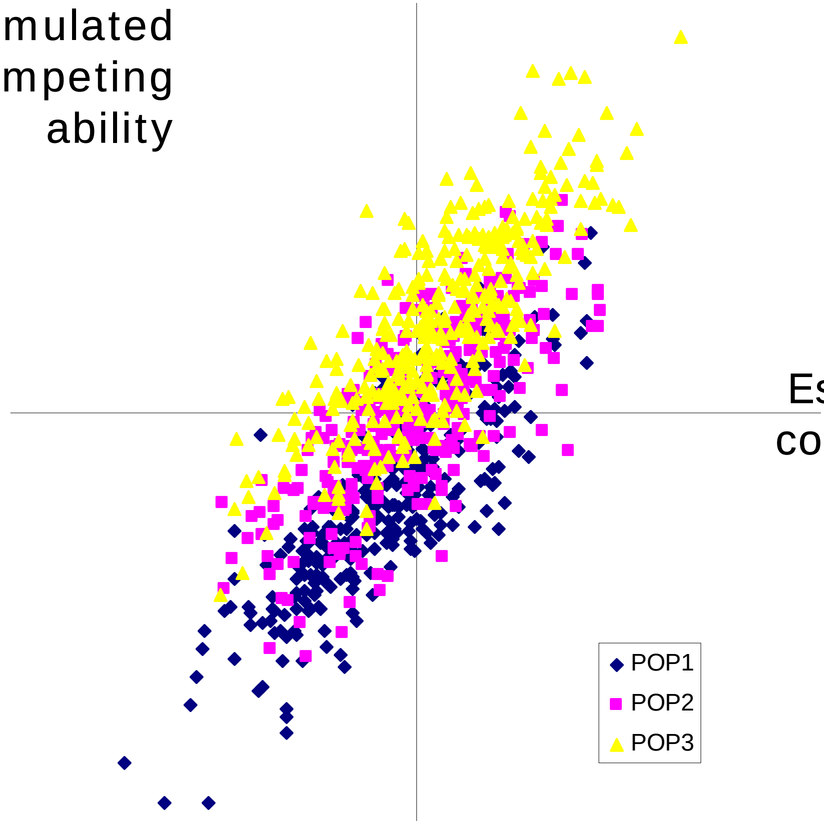
- The « event » or « category of event » or « level » effect is not identifiable

- Mixture model : group of horses rather than events. The performances are a mixture of performances from several horse populations according to their participation to different levels of events.

Underlying Mixture model

Underlying model

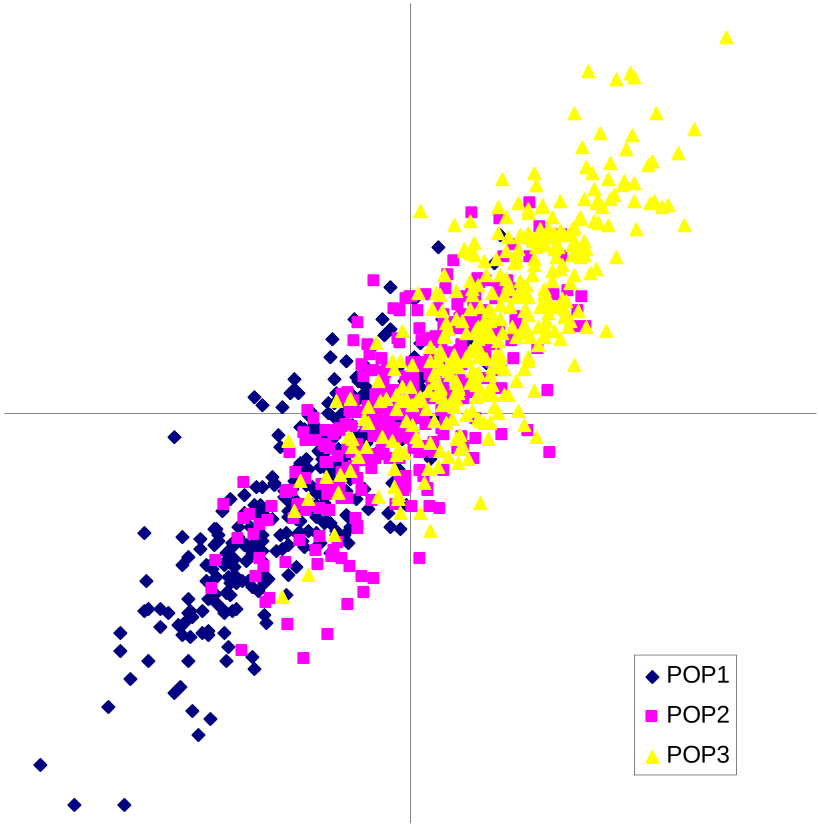
Simulated competing ability



Estimated competing ability

Estimated Repeatability=0.20

Underlying mixture model



Estimated Repeatability=0.28

Conclusion

- Normal score or raw ranks underestimated repeatability of competing ability
- Underlying performance responsible for ranking is The suitable model for horse breeding evaluation. Parameters were correctly estimated, including variances, with a gibbs sampler in unstructured competition (with correct drawing of liabilities) but not sufficient for structured competition
- For structured competition the mixture model of population of horses is a promising way of future adapted models whereas normal score multiple trait models were not suitable

Gibb sampler

- In order to estimate variances and parameters, a Gibbs sampler was built
- As usual except drawing of liabilities (different from Gianola and Simianer, 2006)

1. drawing liability of the last horse *(n)* in truncated normal distribution from –∞ to $l^t_{(n-1)}$ the liability of horse ranked just before him from previous run *t*
2. drawing liability of the horse ranked just before the last from $l^t_{(n)}$ to $l^t_{(n-2)}$ (and not from $l^t_{(n)}$ to + ∞)
3. etc...