

Accelerometry for genetic improvement of gaits of jumping horses.



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EAAP 2018 – Dubrovnik – 27th / 31th August

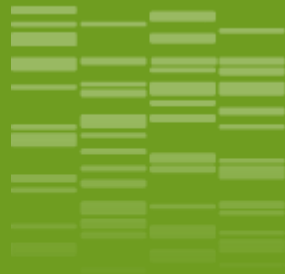


Objective



❖ Analysis of **Gaits of Jumping horses**

- Using an *Objective* measurement of gaits
- In order to compute *Genetic relationship* with jumping in competition
- And to conclude about *selection strategy*



_01

Material

Data



1,477 jumping horses (mostly Selle Français) aged 4 and 5 years
In 27 events during 2 years of recording
10,907 ancestors (4 generations)

Equimetrix® 3-dimensions accelerometer device fixed onto the girth

After an official jumping competition for young horses,
each horse performed a Quick Gait Test including :

walk,
working and medium trot,
working and medium canter,

in an arena with diagonal lines of 60 meters

Data



1477 jumping horses



All performed jumping competition



All results in official jumping competition from birth 1998

232,952 jumping horses

15 years

458,269 annual performances in competition
=log(sum of points according to ranking and technical difficulty)

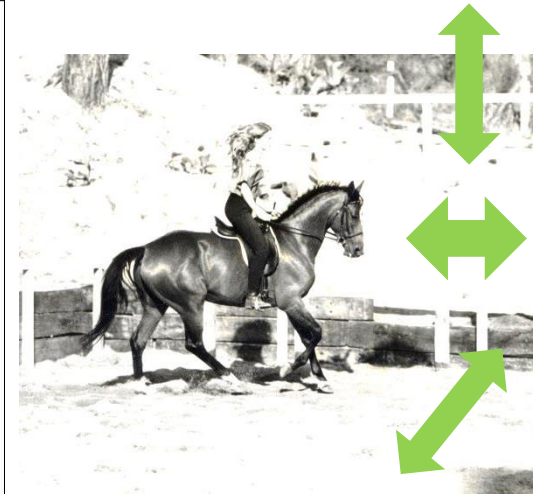
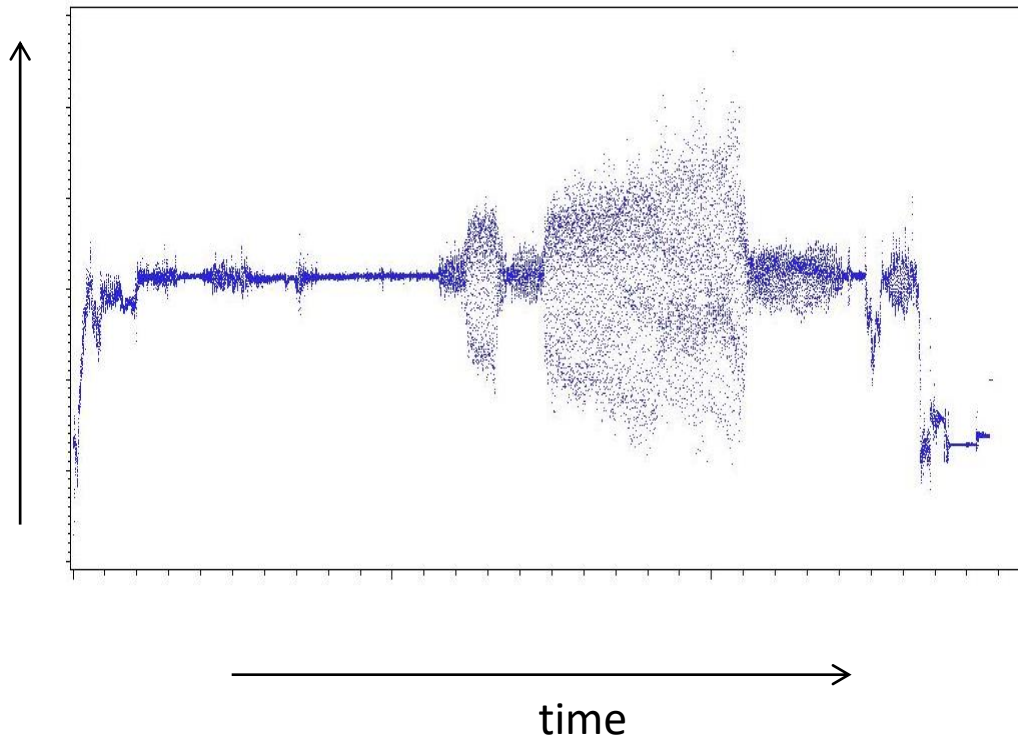
406,750 ancestors (4 generations)



Data : raw data from accelerometry

Acceleration recorded at 100Hz

DorsoVentral
or
Longitudinal
or
Lateral
Acceleration



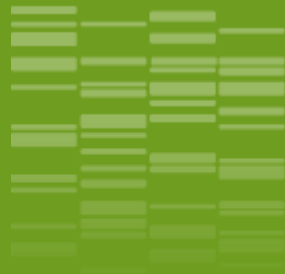
8 measurements

(issued from 10 seconds sample)

- ❖ Velocity (m/s)
- ❖ Stride Frequency (stride/s)
- ❖ Regularity (correlation between strides)
- ❖ Symmetry (correlation between the right and left beat, Log)
- ❖ DorsoVentral displacement (cm)
- ❖ DorsoVentral activity (g^2/Hz), Log transform
- ❖ Longitudinal activity (g^2/Hz), Log transform
- ❖ Lateral activity (g^2/Hz), Log transform

* 5 gaits = 38

- ❖ Walk
- ❖ Working Trot
- ❖ Medium Trot
- ❖ Working canter
- ❖ Medium canter



_02

Questions and Answers

How can we summarize the main characteristics of the walk, trot and canter?

Principal Component Analysis (PCA)
of measurements corrected for
Velocity, Sex, Age, Event

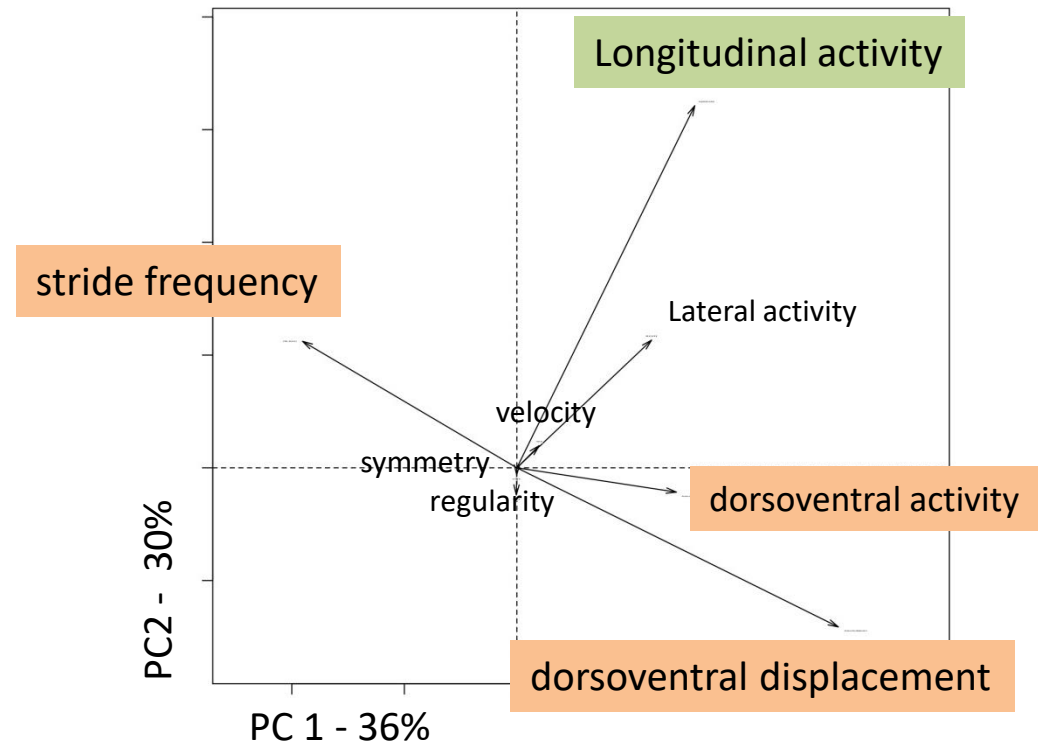
Trot / Canter

- 1) *Low Stride Frequency with High Dorsoventral displacement and activity*
- 2) Longitudinal activity
- 3) Lateral activity

Walk

- 1) *High Dorsoventral activity and high regularity and symmetry*
- 2) *Stride Frequency and Longitudinal activity*
- 3) Symmetry

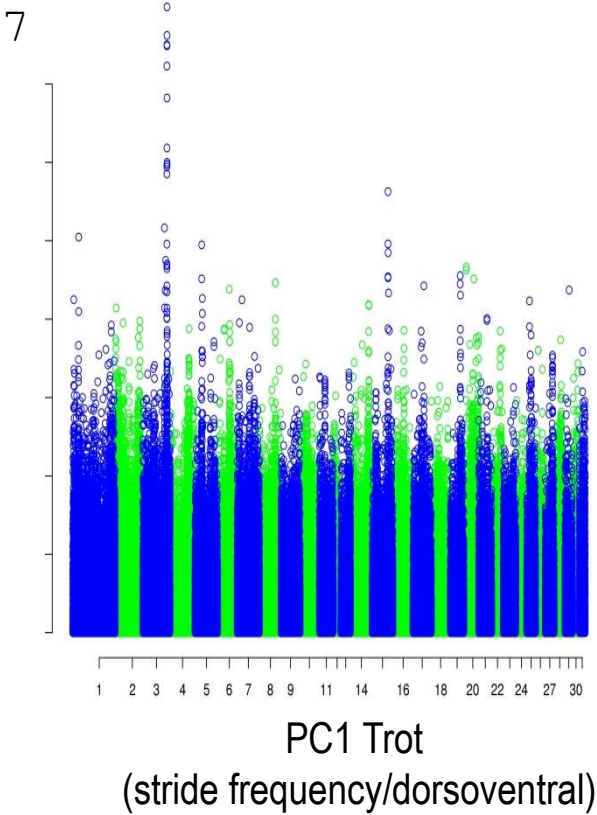
Ex : Trot



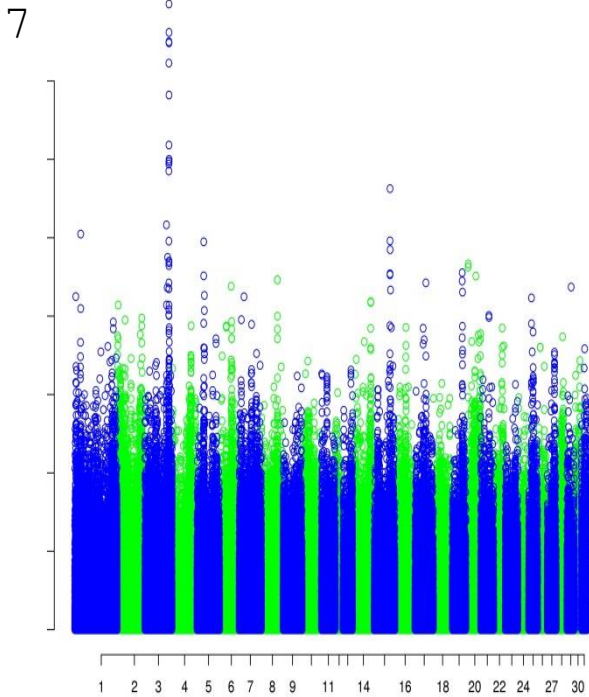


- Genetic analysis of the 9 principal components (3 for walk, 3 for trot, 3 for canter)

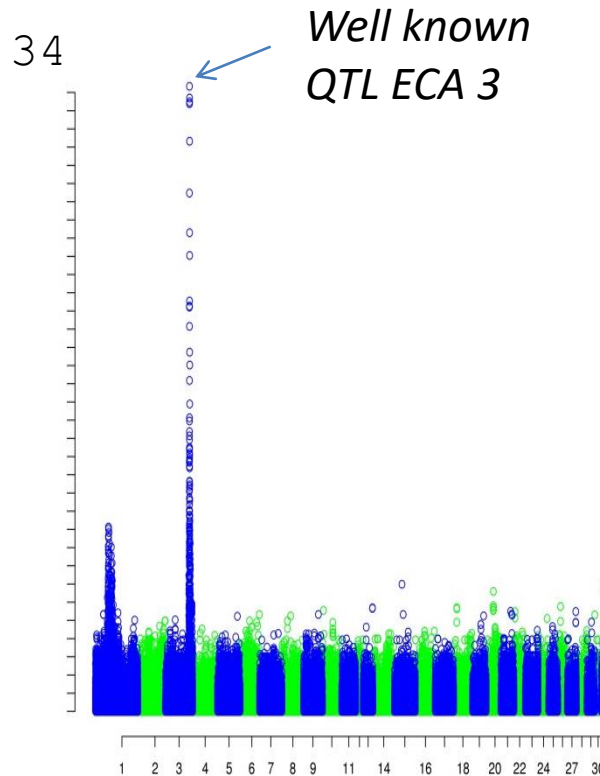
GWAS → what is the influence of the height in the gait characteristics?



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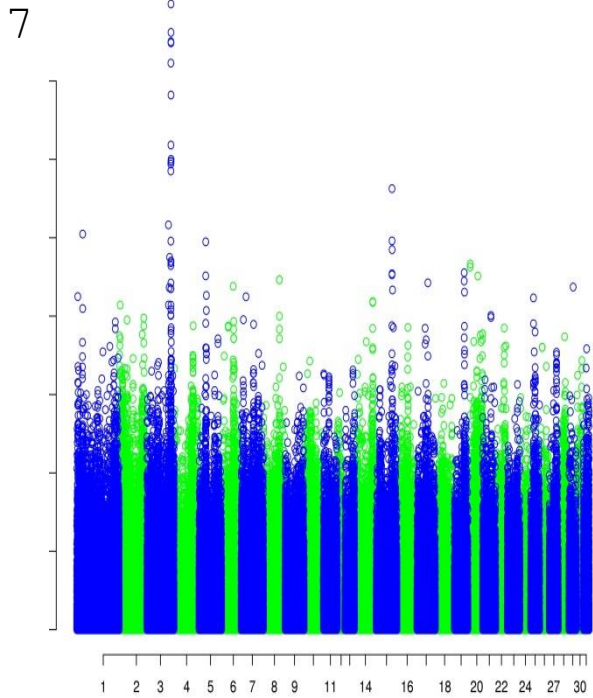


PC1 Trot
(stride frequency/dorsoventral)

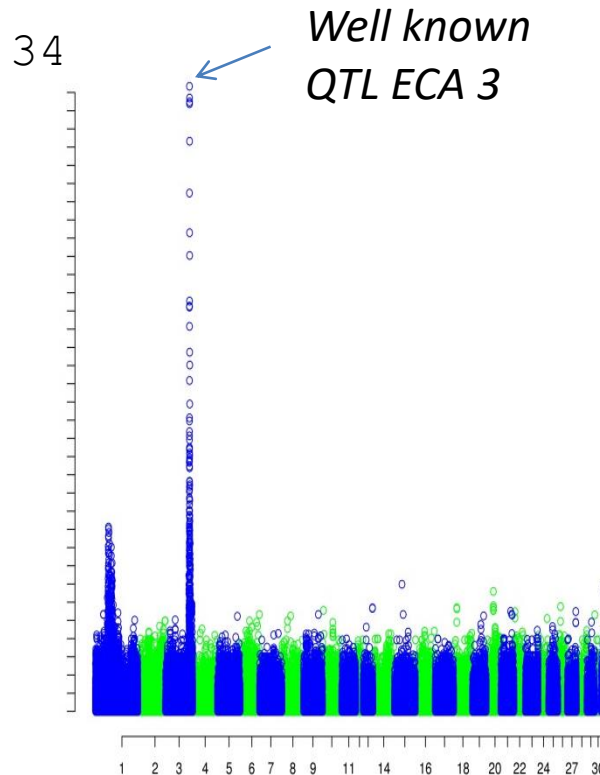


Height at wither

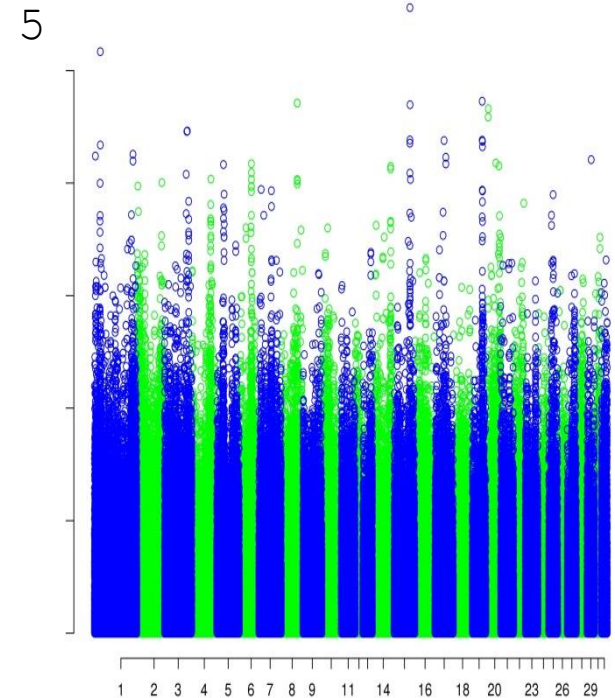
GWAS → what is the influence of the height in the gait characteristics?



PC1 Trot
(stride frequency/dorsoventral)



Height at wither



PC1 Trot
adjusted for height

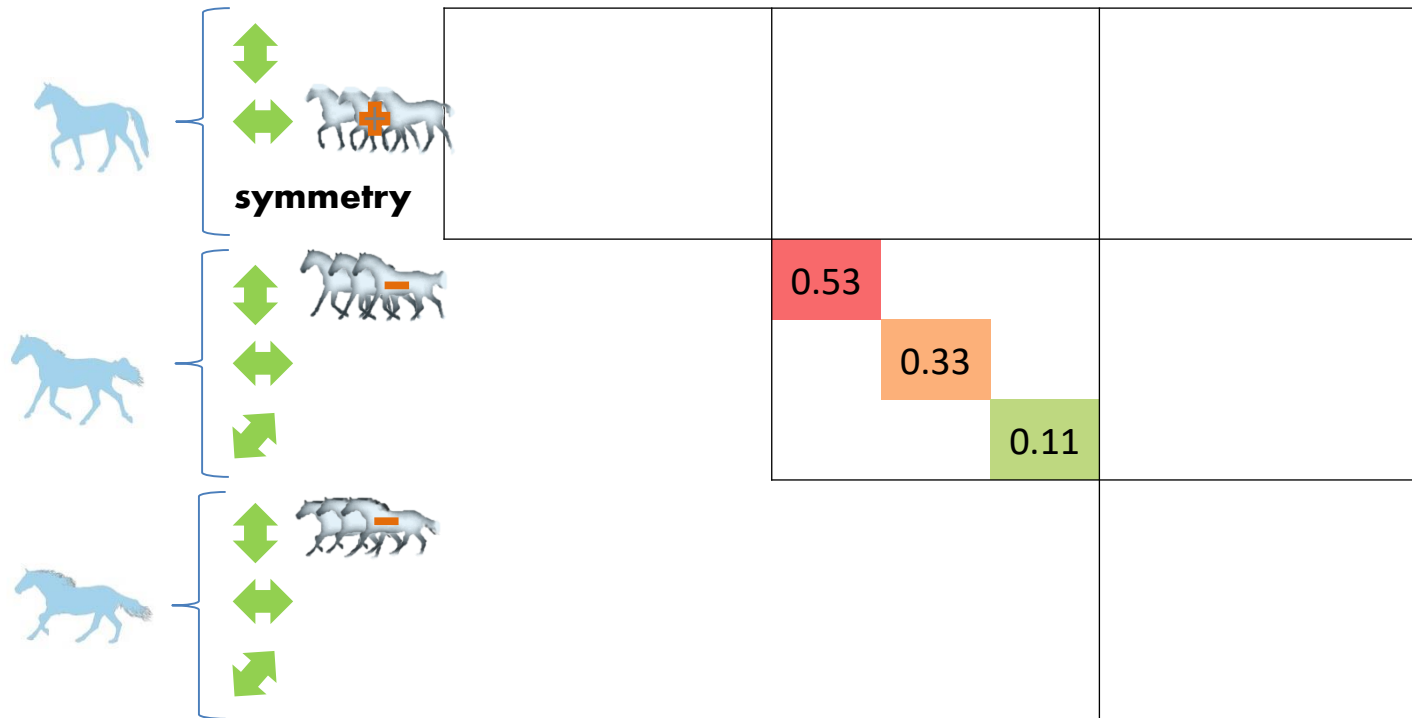


Height influenced genetically the gait characteristics

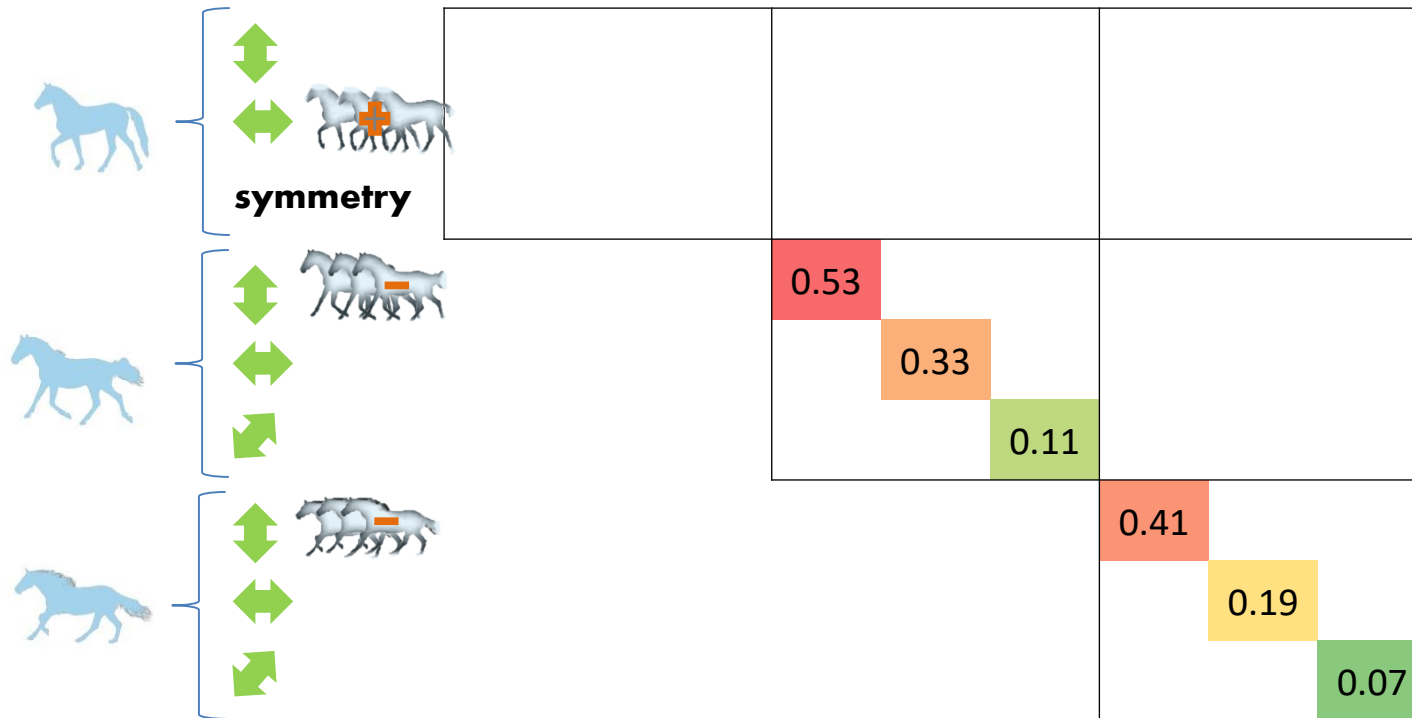
We want to select gait characteristics independently of height, and eventually use height as a trait to select if wanted

- Multiple trait animal model with 10 traits :
 - The 9 Principal Components. The model included velocity, **height**, age, sex and event fixed effects
 - Height. The model included sex fixed effect.
- Called Structural Equation Model (Gianola & Sorensen, 2004)

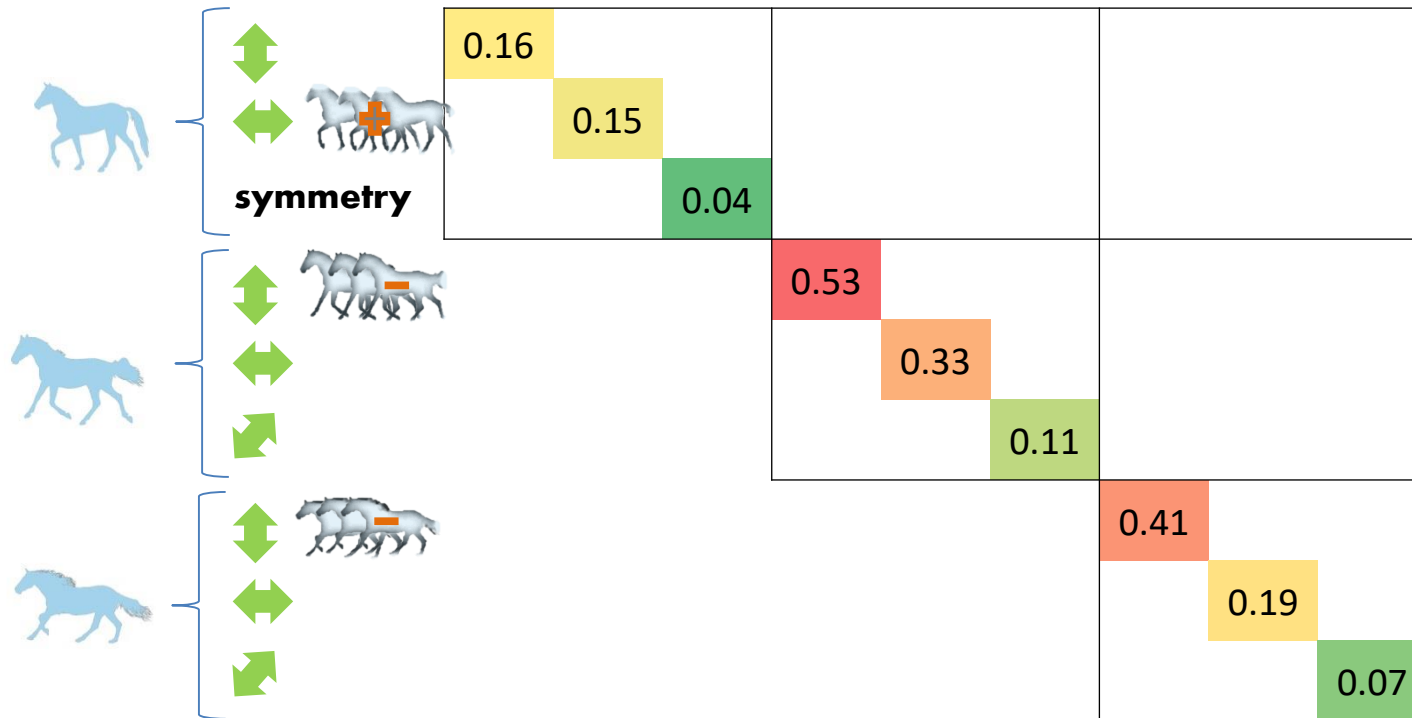
Heritability and Genetic correlation



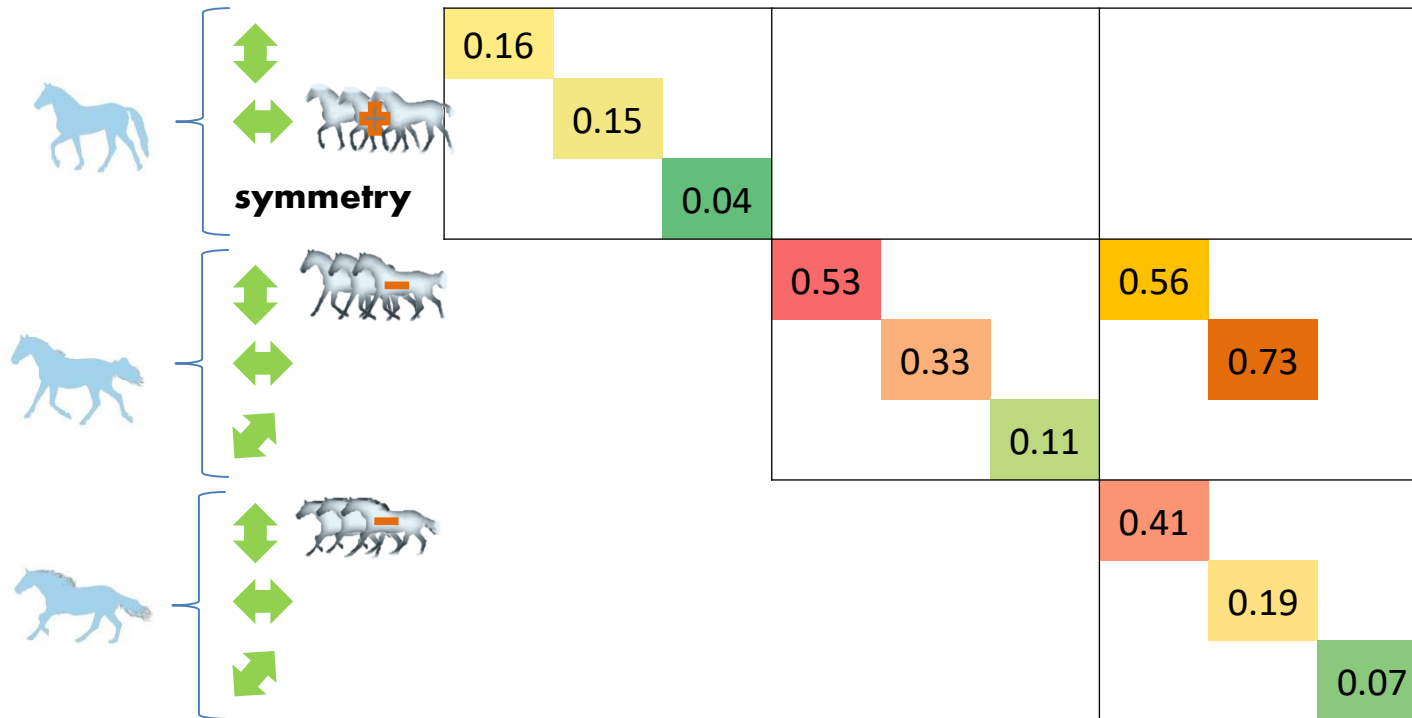
Heritability and Genetic correlation



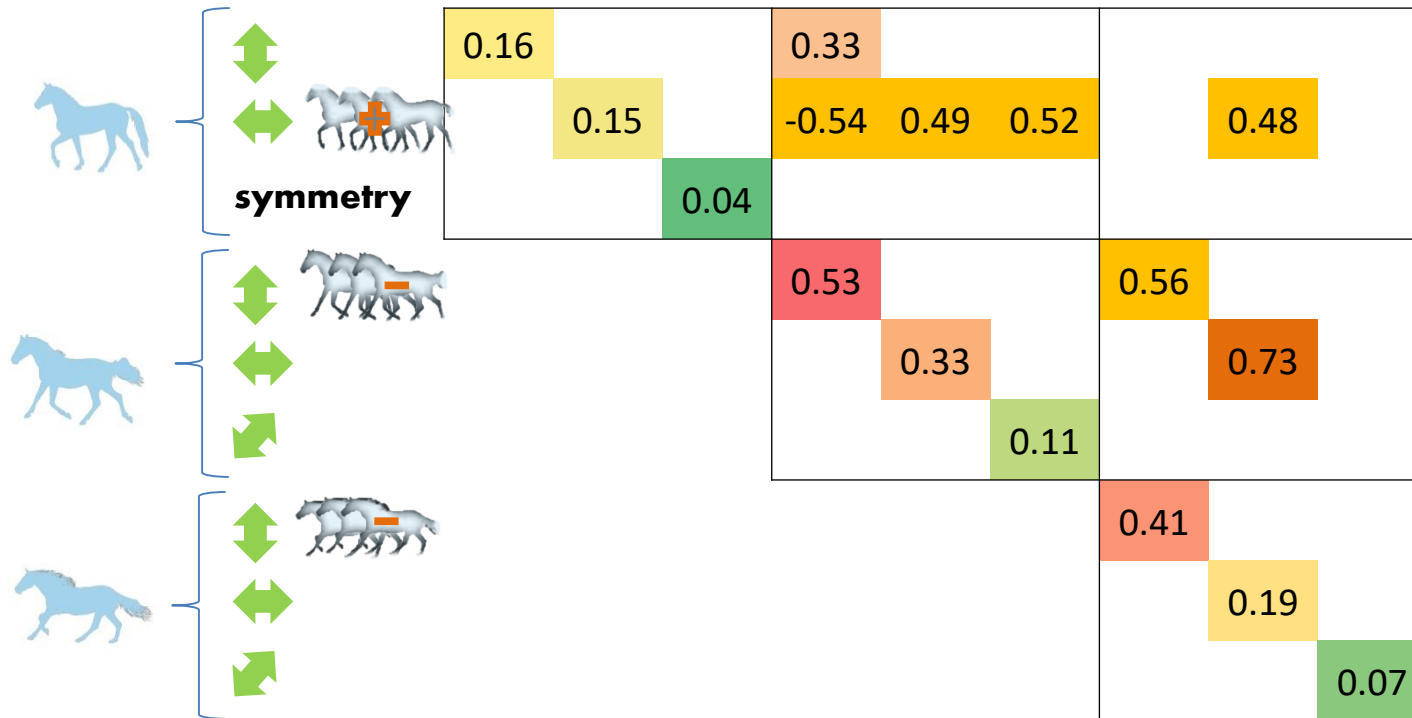
Heritability and Genetic correlation



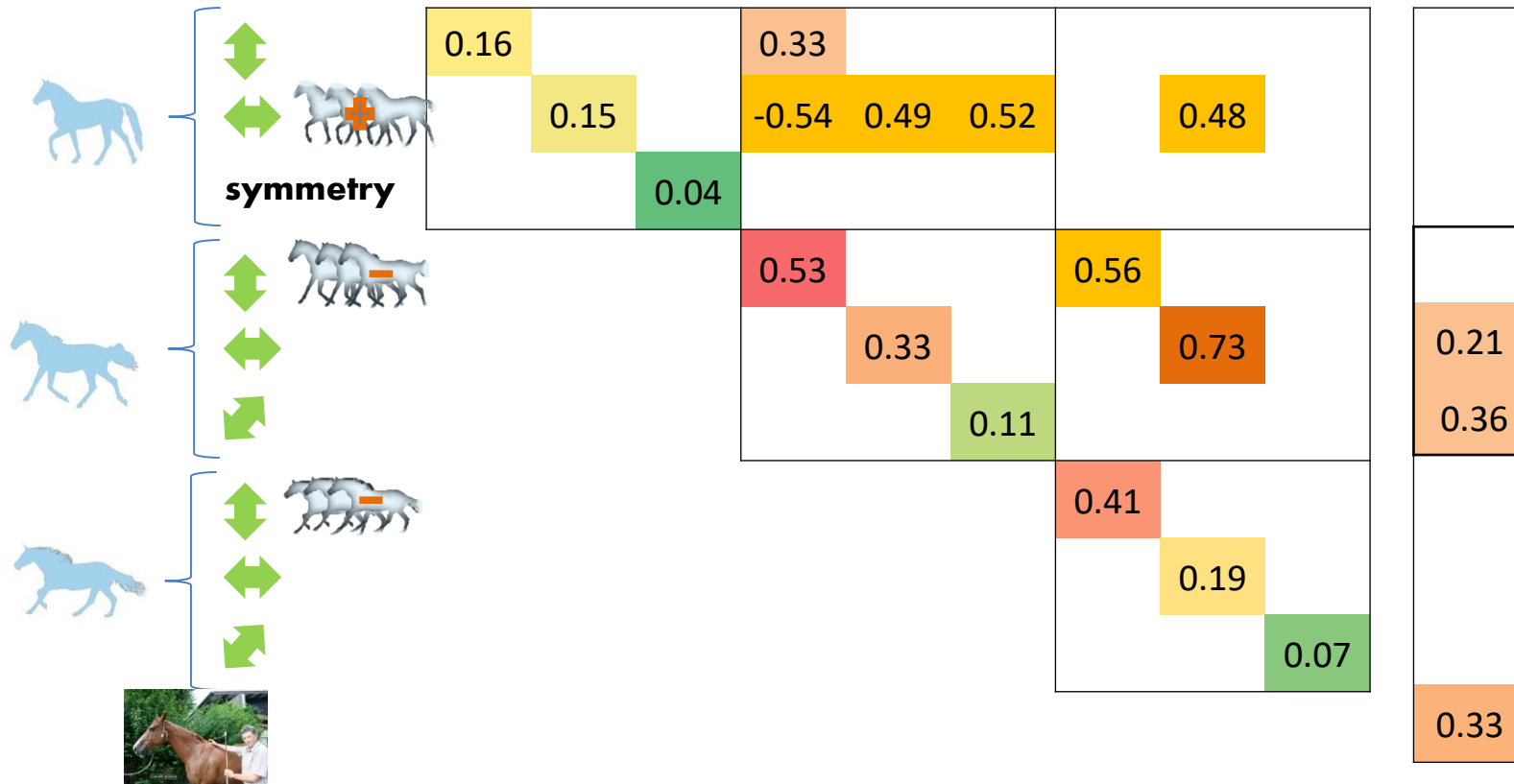
Heritability and Genetic correlation



Heritability and Genetic correlation



Heritability and Genetic correlation





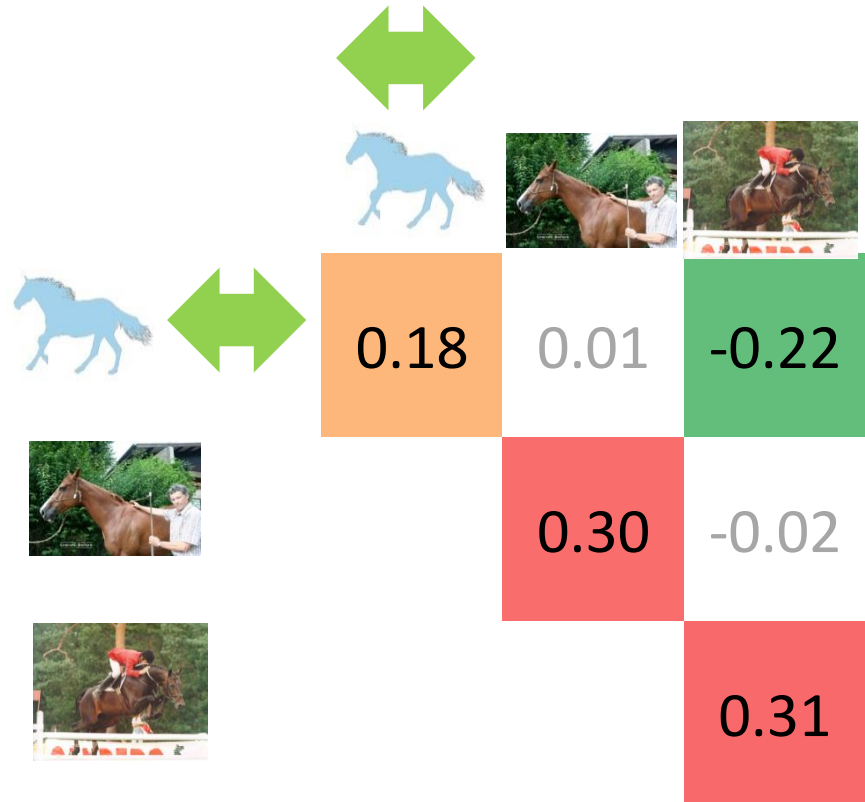
Genetic correlation with jumping competition



Over the 9 possible correlations
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(summarizing 38 measurements)
only one
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Genetic correlation with jumping competition

Over the 9 possible correlations between the 9 PC and jumping performance (summarizing 38 measurements) *only one* was significantly different from 0 : the PC2 canter, longitudinal activity



Conclusion

Accelerometry is an appropriate tool to analyze gaits with high heritable traits

Selection for suitable gaits, whatever they are, is possible without loss on jumping competition objective

Exception is for unfavorable longitudinal activity at canter. This measurement was corrected for height and velocity. So, this activity represents mostly variation in acceleration to maintain the same velocity without efficacy.

Conclusion

Breeding values may be provided as several useful tools :

- **EBV for height at withers, including genotypes at major QTLs**
- **Regression coefficients to predict influence of realized height on gaits**
- **EBV for gaits traits corrected for height to improve them without changing height**
- **EBV for jumping performance in competition (the only one yet available since 32 years!)**



Genetic correlation with jumping competition

Tri-trait model

-1 Principal Component

- Height

- Competition jumping perf.

$$y = Xb + \lambda h + Za + Zp + e$$




















$$h = X\beta + Za + Zp + e$$

$$y = X\alpha + Za + Zp + e$$

Log(annual
sum of
points)

age*year*sex

Height coefficient of regression

			0.013	0.025	NS
			-0.050	0.024	*
	symmetry		-0.044	0.027	NS
			0.216	0.022	***
			-0.217	0.020	***
			-0.081	0.017	***
			0.137	0.019	***
			-0.176	0.016	***
			0.044	0.021	*

Data : 10 seconds samples

Canter

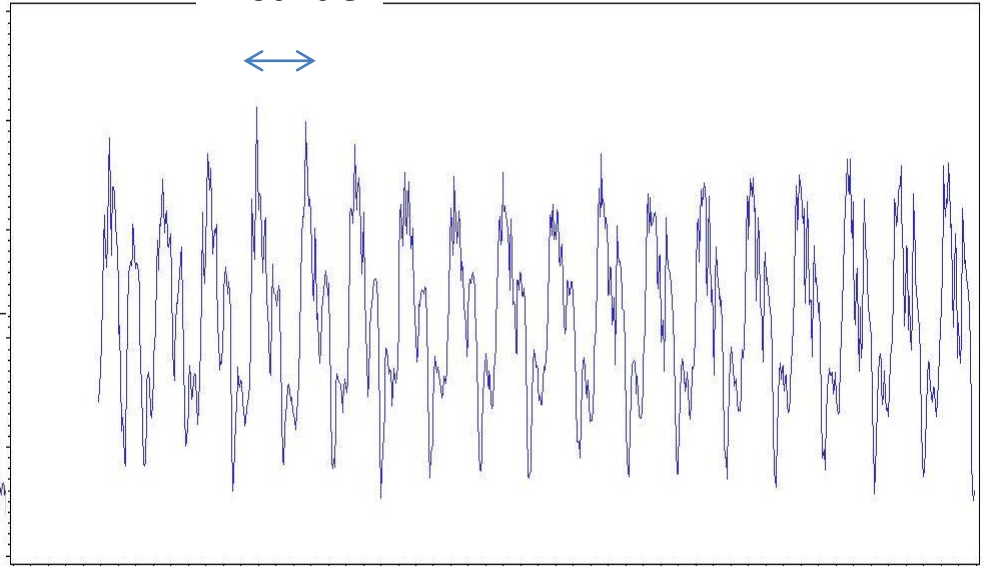
DorsoVentral
Acceleration

Trot

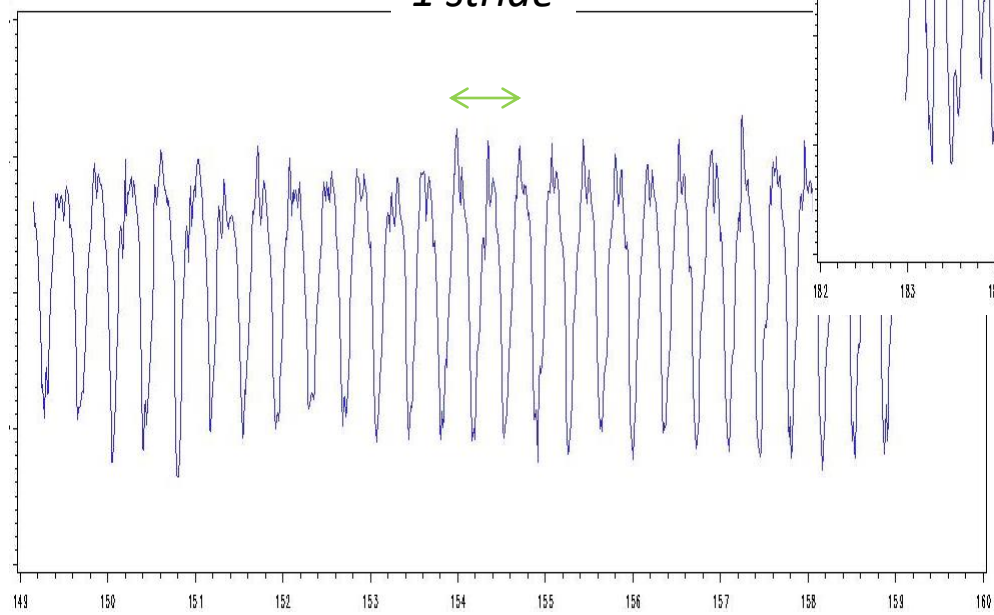
1 stride



1 stride



182 183 184 185 186 187 188 189 190 191 192 193



149 150 151 152 153 154 155 156 157 158 159 160