



SMALL RuminanTs breeding for Efficiency and Resilience

Evaluation of novel resilience phenotypes based on longitudinal performance measures

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Capacity to

1- maintain , and

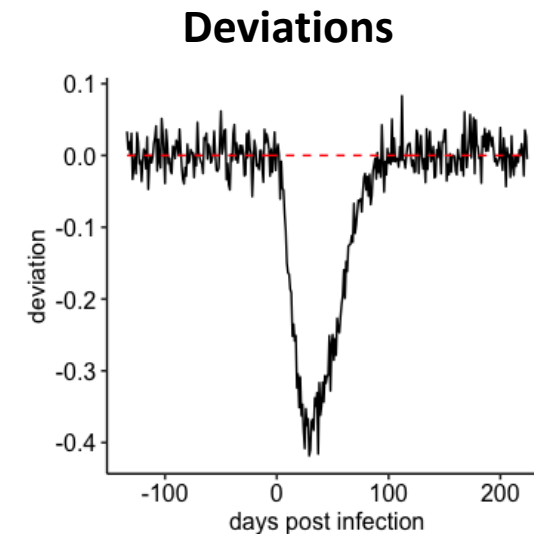
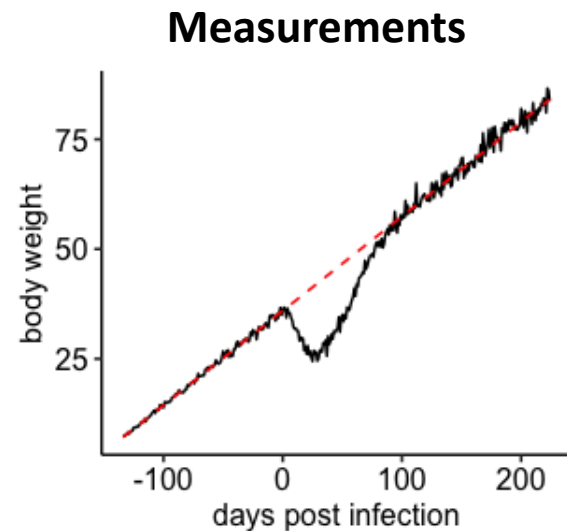
2- revert quickly to ***

unperturbed production, high health and welfare trajectory when exposed to diverse challenges

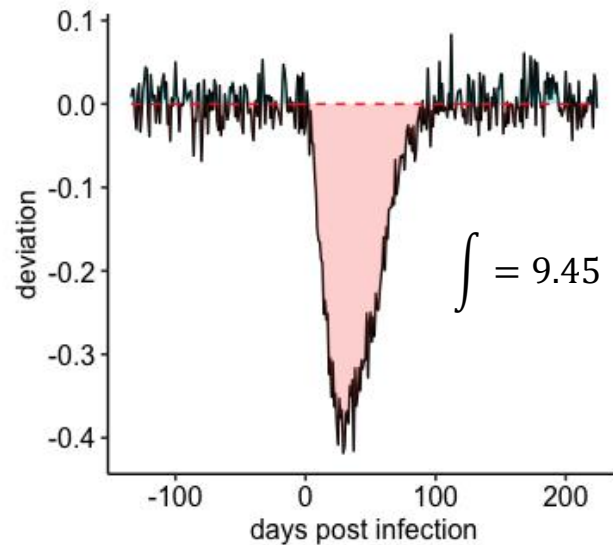
Required data:

- Longitudinal performance measures over a challenge period
- Target trajectory for performance measure (i.e., in absence of challenge)

— Realised performance
- - - Target trajectory (may not be known)



Area under the curve
of deviations from
target trajectory



Resilience Indicators (RI)

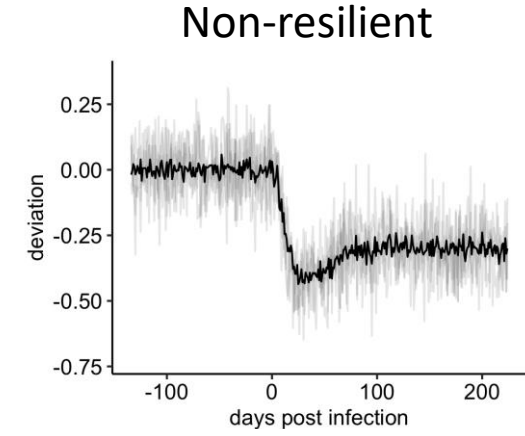
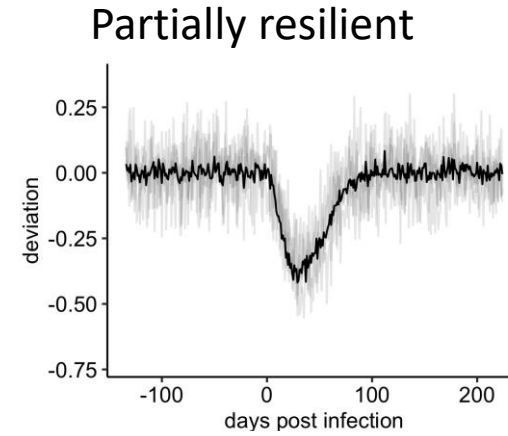
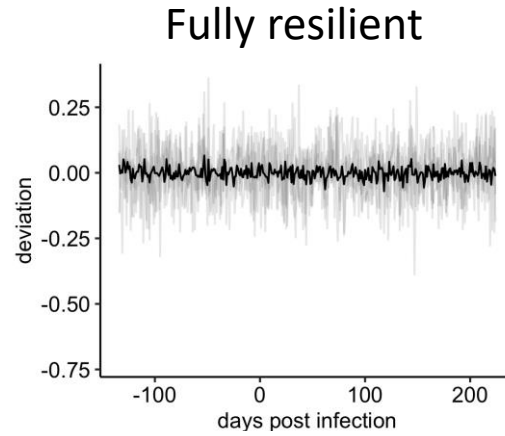
- Area under curve
- Autocorrelation
- Mean square
- Skewness
- Variance

Objectives for validating the statistical resilience indicators

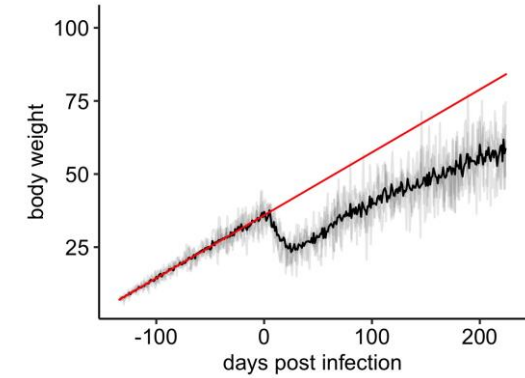
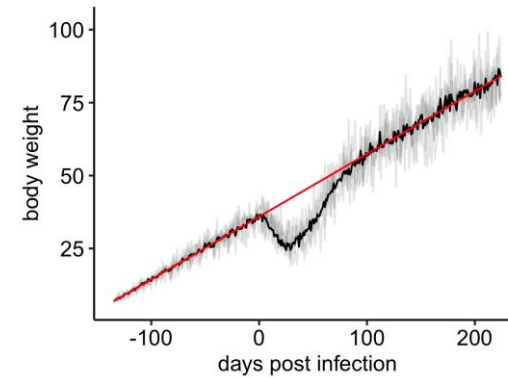
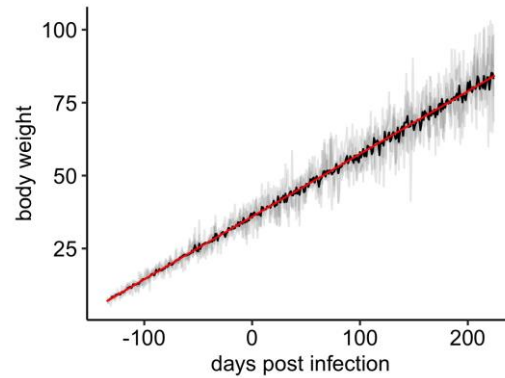
- Do different response types have different values for RIs?
- How sensitive are the RIs to differences in the amplitude of perturbation, recovery speed and data structure?
- Do different methods for estimating target trajectories affect the RI estimates?

Potential responses to a challenge

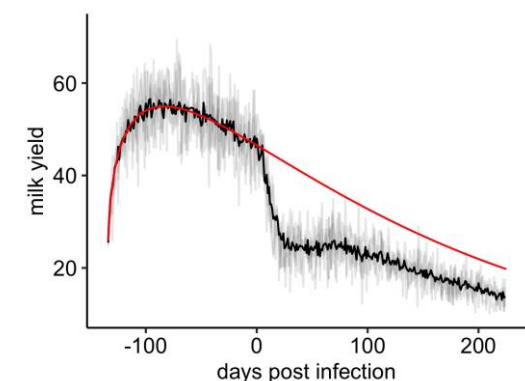
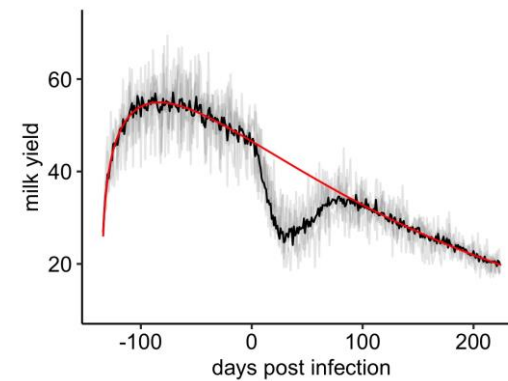
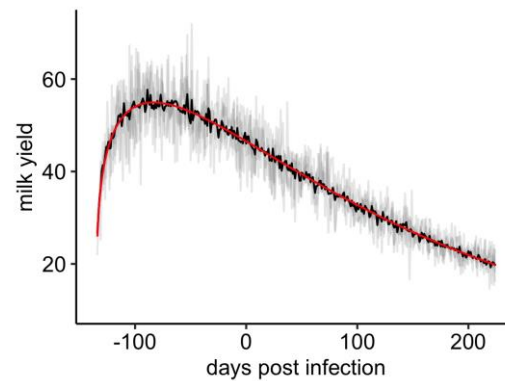
Known
target
trajectory

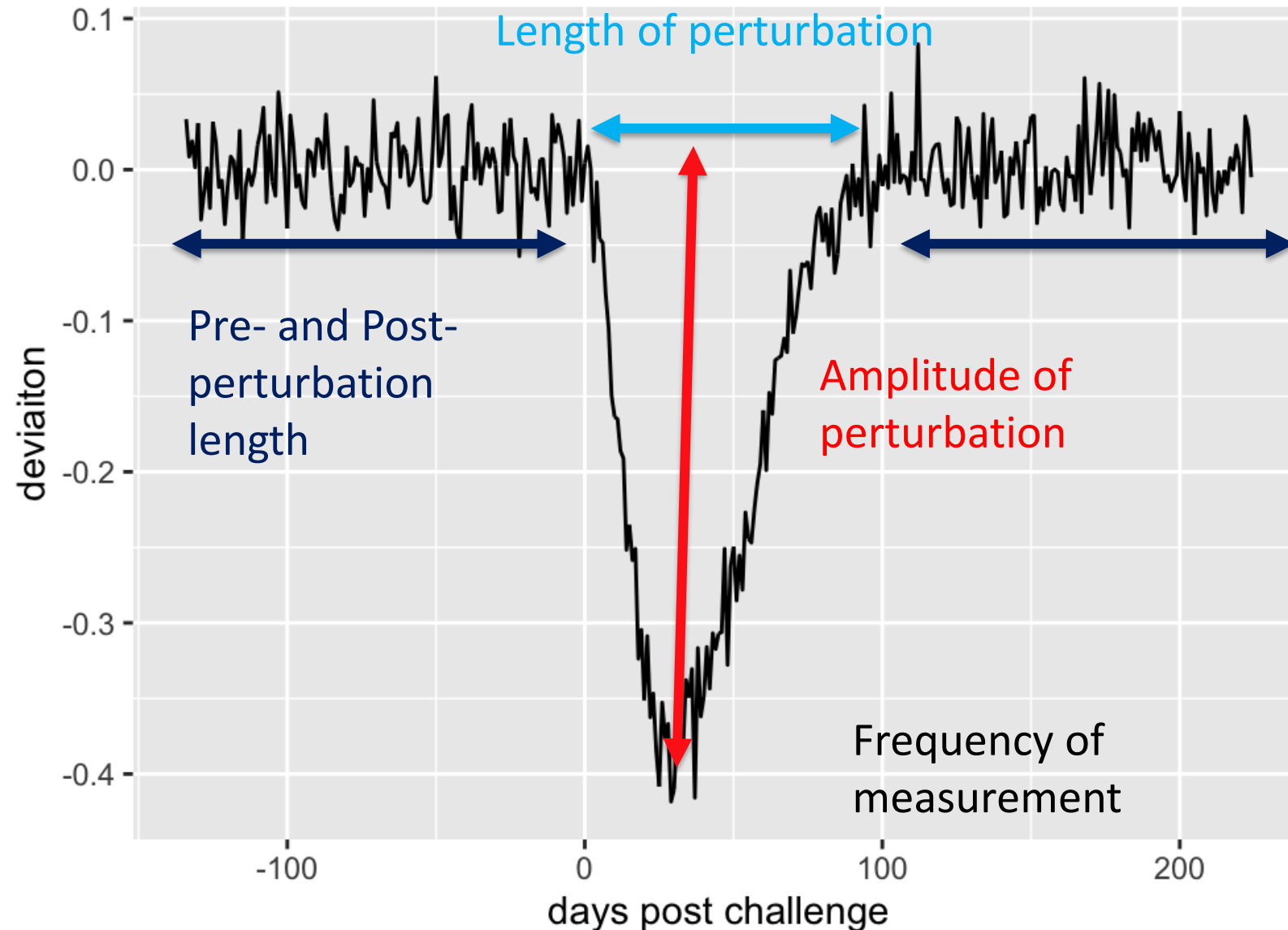


Unknown
linear
target
trajectory



Unknown
non-linear
target
trajectory





Sensitivity of Resilience indicators on data structure and recovery features for

- Known
- Unknown

target trajectories

Groups: fully resilient, partially resilient, non-resilient

Resilient indicators: variance, AUC, skewness, MS, autocorrelation

- **All RIs can distinguish the fully resilient animals from partially or non-resilient animals**

When target trajectory is known:

- **Skewness cannot correctly distinguish between partial and non-resilient**

When target trajectory is unknown:

- **Skewness and autocorrelation cannot correctly distinguish between partial and non-resilient**
- **Results similar regardless of method used for estimating target trajectory (quantile or repeated regression)**

- **Length of Pre/Post perturbation:** Possible reranking of partial and non-resilient group in extreme cases (no pre-perturbation data)
- **Frequency of measurement:** RI generally robust with respect to frequency of measurement up-to biweekly (except autocorrelation)
- **Amplitude of perturbation:** All R.I. values increased with an increase in amplitude
- **Length of perturbation:** Possible re-ranking of partial and non-resilient for long perturbation period

More information and detailed results on the SMARTER report and manuscript (in-preparation)

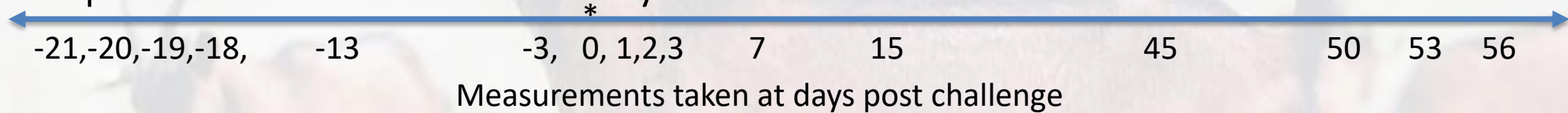
- RIs work best with regular and frequent measurements
- All resilient indicators work well for fully-resilient animals
- Risk of wrong ranking when comparing partial- and non-resilient
 - ✓ Include pre- and post-perturbation data
 - ✓ Use AUC, mean-square and variance
 - ✓ Adjust for differences in onset of perturbation

Validation of RI with real data - LPS challenge in dairy goats

Number of animals: 45 primiparous dairy goat (18 low-longevity, 27 high-longevity)
See Ithurbide et. al. 2022

Traits: milk yield, milk composition, somatic cell score

16 repeated measurement over 77 days



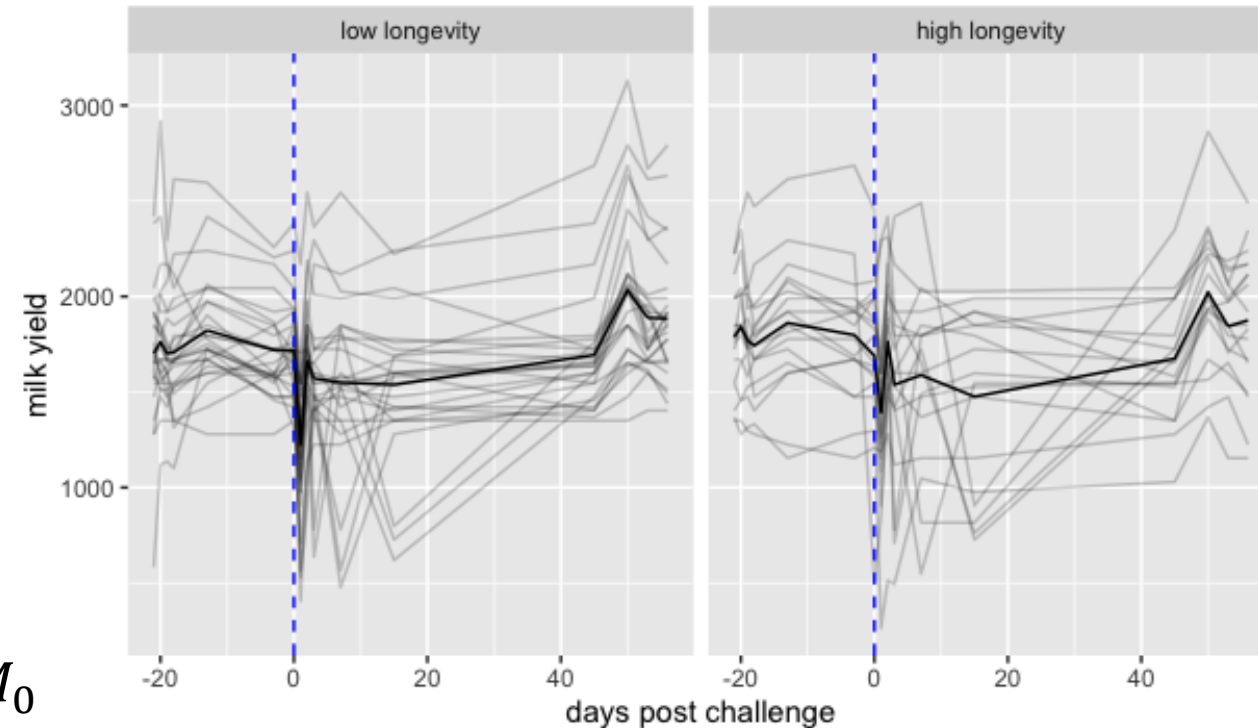
Animals challenged with LPS (day 0)

Do RIs show any difference between the two divergently selected lines?

- Estimate individuals' target trajectories for each trait
- Calculate deviations from target trajectory
- Calculate RI phenotypes (e.g. Area under the curve)
- Fit general linear model to RI phenotypes

$$RI \sim line + age + line:age + litterSize + DIM_0$$

- Compare estimates of line differences in RIs prior and post challenge to identify if the goat lines differ in their resilience to LPS challenge



F-statistics (p-values) for line differences in RI

trait	Before challenge			Before and after challenge		
	AUC	Log-variance	Log-MS	AUC	Log-variance	Log-MS
Milk	0.4818	0.7613	0.6467	0.2288	0.5728	0.6110
Fat content	0.5760	0.4041	0.5193	0.6477	0.0759	0.12343
Protein content	0.5757	0.1072	0.0686	0.0434 *	0.0314 *	0.0187 *
SCS (Line:age)	0.02519 *	0.04067 *	0.04558 *	0.06905	0.9459	0.17119

Preliminary result from small dataset

- The different goat longevity lines respond differently in milk protein content (and possibly in SCS)
- No difference in milk yield and fat content
- The non-resilient group does not exist in dataset
 - Variance, mean-square, and AUC methods can be applied and reliable
 - Autocorrelation cannot be applied due to irregular recording

SMARTER PARTNERS



Thank you for your attention

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