FMDV in African Buffalo
Influence of immunity in the spread of wildlife diseases

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Foot and Mouth Disease (FMD)

- Antibody level dynamics behave like a random walk given by a Markov Process

$$P(t \mid \boldsymbol{\theta}) = \begin{pmatrix} P_{\mathrm{l}}(t \mid t_0 = 0) & P_{\mathrm{h}}(t \mid t_0 = 0) \\ P_{\mathrm{l}}(t \mid t_0 = 1) & P_{\mathrm{h}}(t \mid t_0 = 1) \end{pmatrix}$$

- The transition probabilities can be described through

$$\frac{\mathrm{d}}{\mathrm{d}t} P_{\mathrm{h}}(t) = \lambda_{\mathrm{l}}(t) - (\lambda_{\mathrm{l}}(t) + \lambda_{\mathrm{h}}(t)) P_{\mathrm{h}}(t) = \eta(t) - \gamma(t) P_{\mathrm{h}}(t)$$

- Whenever $\lambda_{\mathrm{l}}(t)$ and $\lambda_{\mathrm{h}}(t)$ are determined integrable functions, the solution is given by

$$P_{\mathrm{h}}(t) = \left(\int_{t_0}^{t} \exp\left\{ \int_{t_0}^{s} \gamma(\tau) d\tau \right\} \eta(s) ds - P_{\mathrm{h}}(t_0) \right) \exp\left\{ - \int_{t_0}^{t} \gamma(s) ds \right\}$$

Maximum Likelihood Estimators and two proposed models

We compare the following two models:

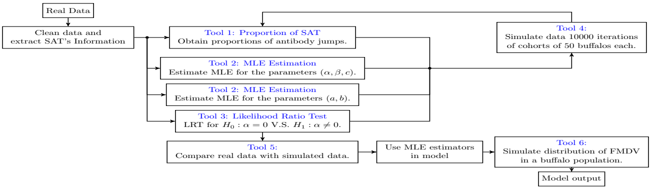
Model	$\lambda_{\mathrm{l}}(t)$	$\lambda_{\mathrm{h}}(t)$
Model 1	a	b
Model 2	$\left(\frac{\alpha-\beta}{t_{end}-t_{start}}\right)t+\left(\frac{\alpha-\beta}{t_{end}-t_{start}}t_{start}+\alpha\right)=ct+d$	e

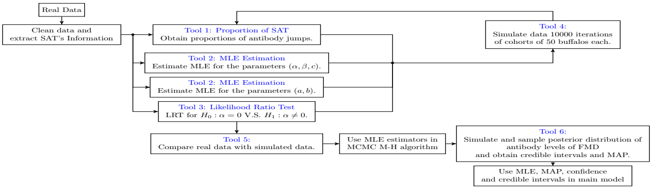
Whenever $\alpha=\beta$ in Model 2, it reduces to Model 1; by using the Maximum Likelihood Estimator (MLE) and design the following hypothesis test

$$H_0: \quad \alpha=\beta \qquad \text{v.s.} \qquad H_1: \alpha\neq\beta$$

we can decide which model fits better our experimental data

Proposed Workflow and final workflow





For further information see
github.com/ricardoreyesgrimaldo/FMDV-immunity

Frequentist and Bayesian results for SAT1