Methodological challenges in estimating brucellosis transmission risk in an Alpine ibex population using Approximate Bayesian Computation

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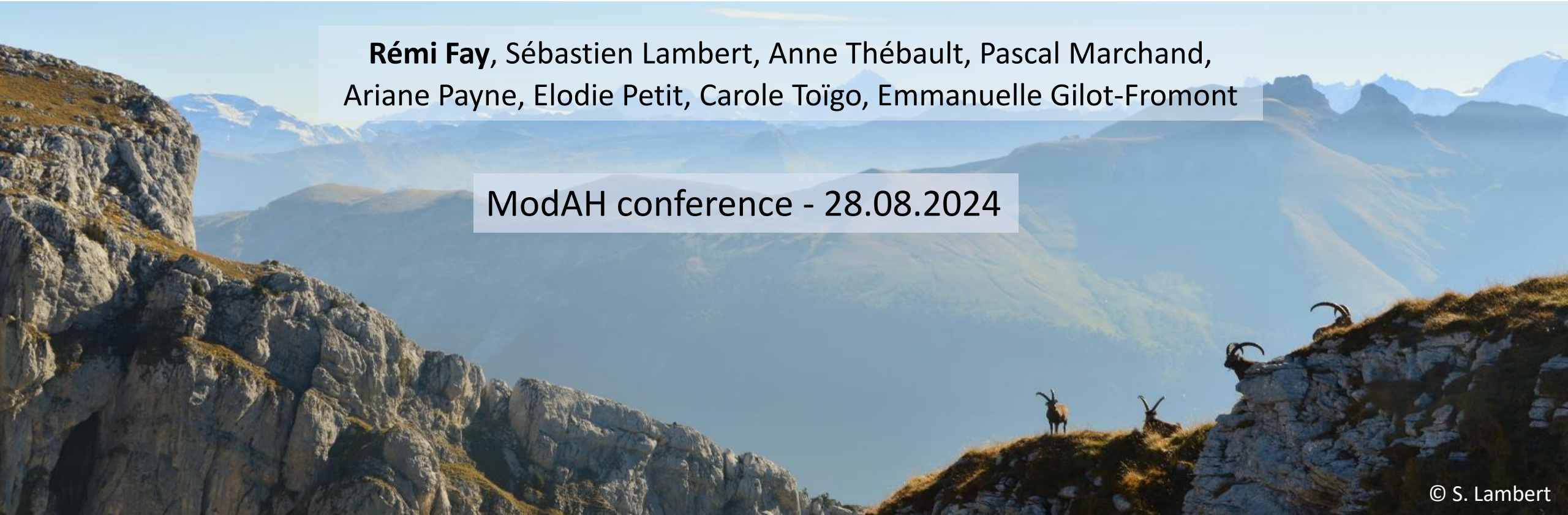
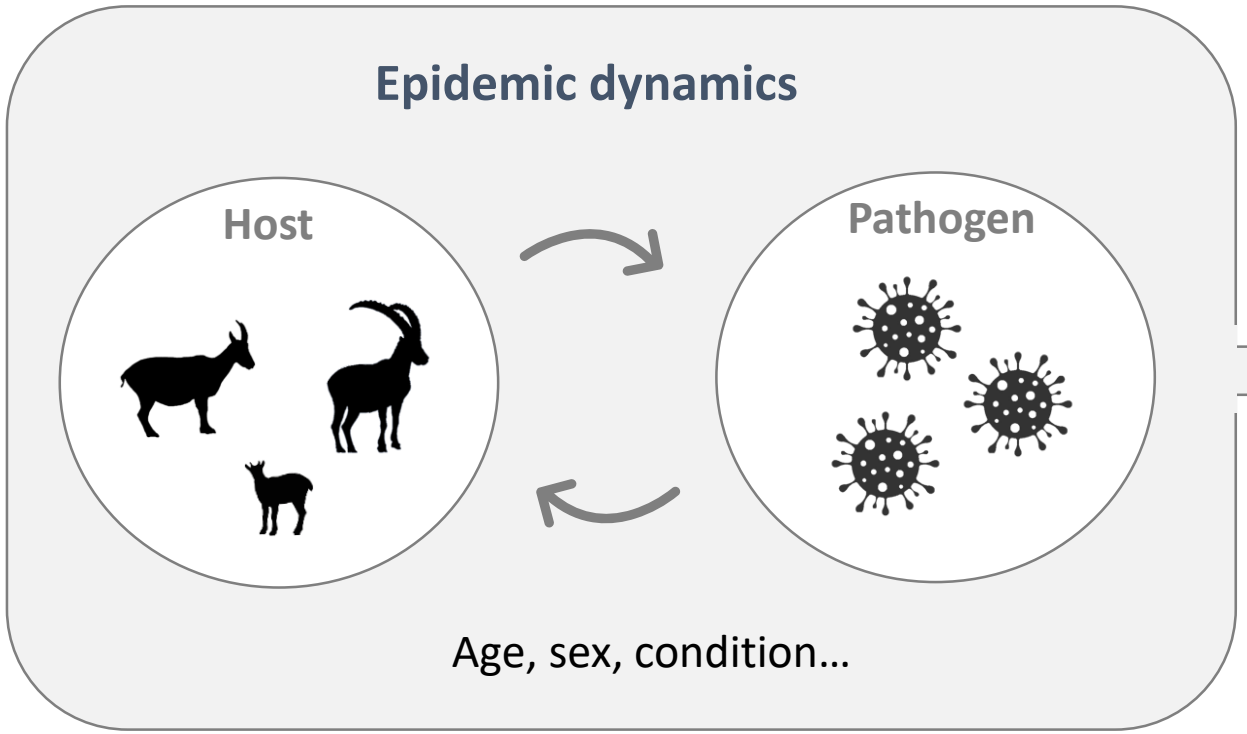
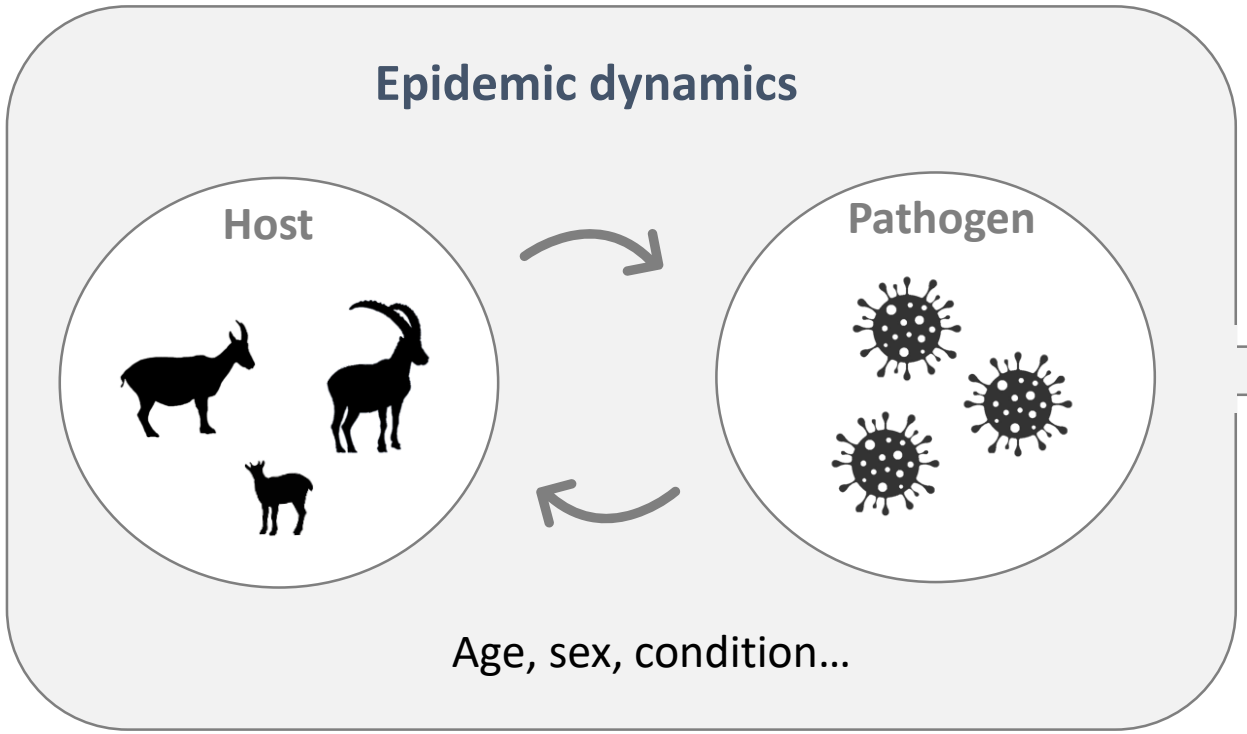


Introduction



Complex models

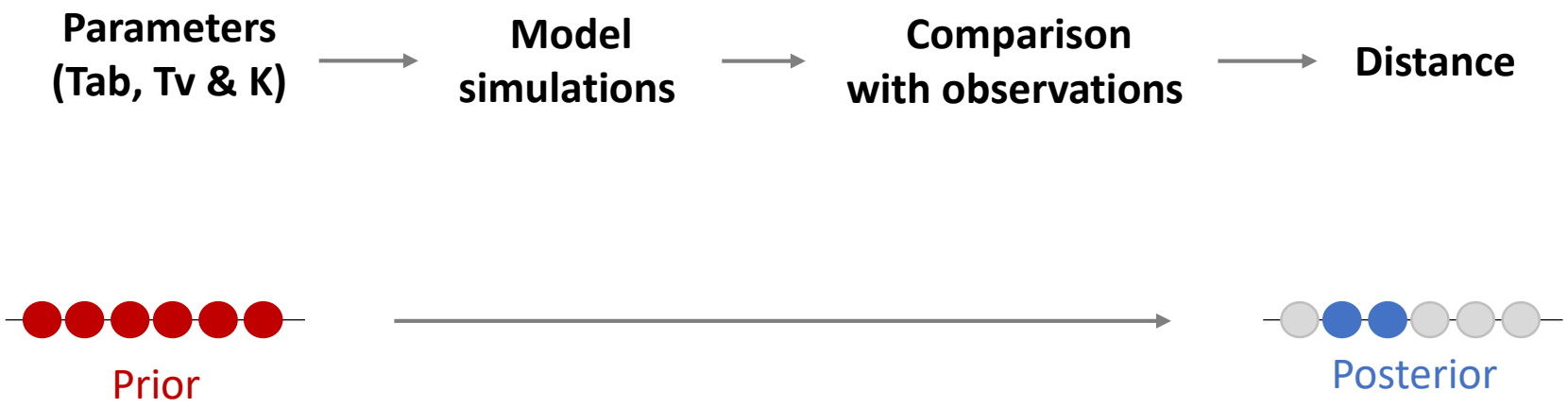
Introduction



Parameters
e.g. transmition rate

Introduction

ABC method (Approximate Bayesian Computation)



Easy at first sight but could be complexe in practice …

Study case

Brucellosis epidemic (2012-2024)

Bacterial disease

Reservoir

Seroprevalence 40%

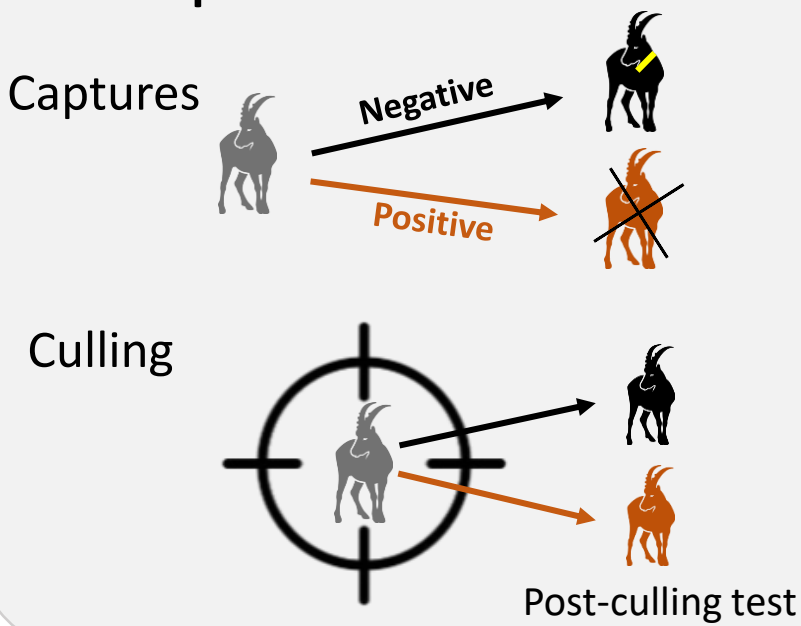
Two transmission pathways

Infectious Abortion & Birth
→ horizontal + vertical transmissions

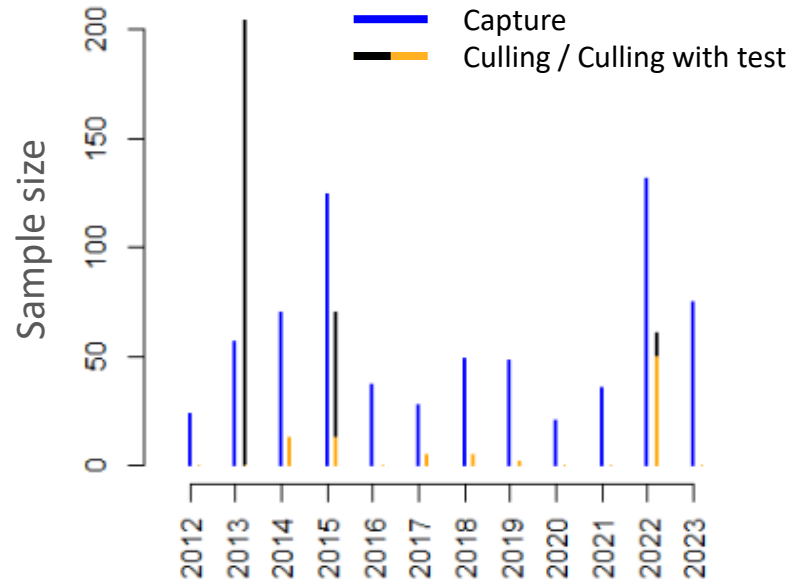
Venerian transmission

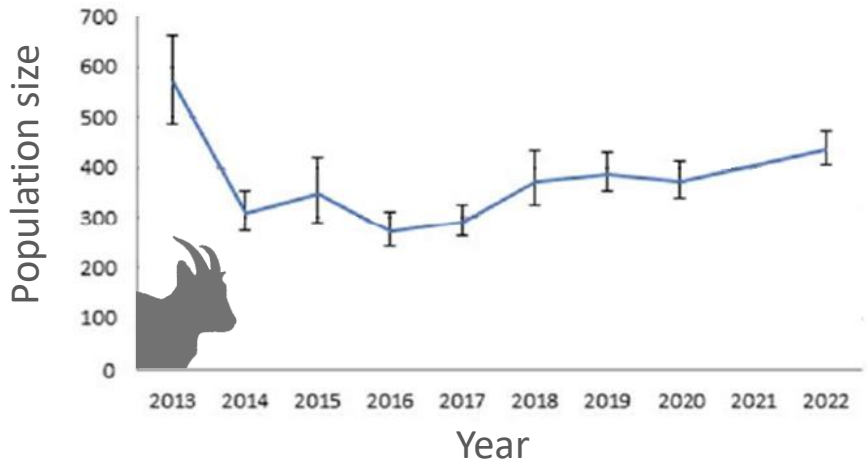
Disease management & data collection

Seroprevalence



Population size estimates



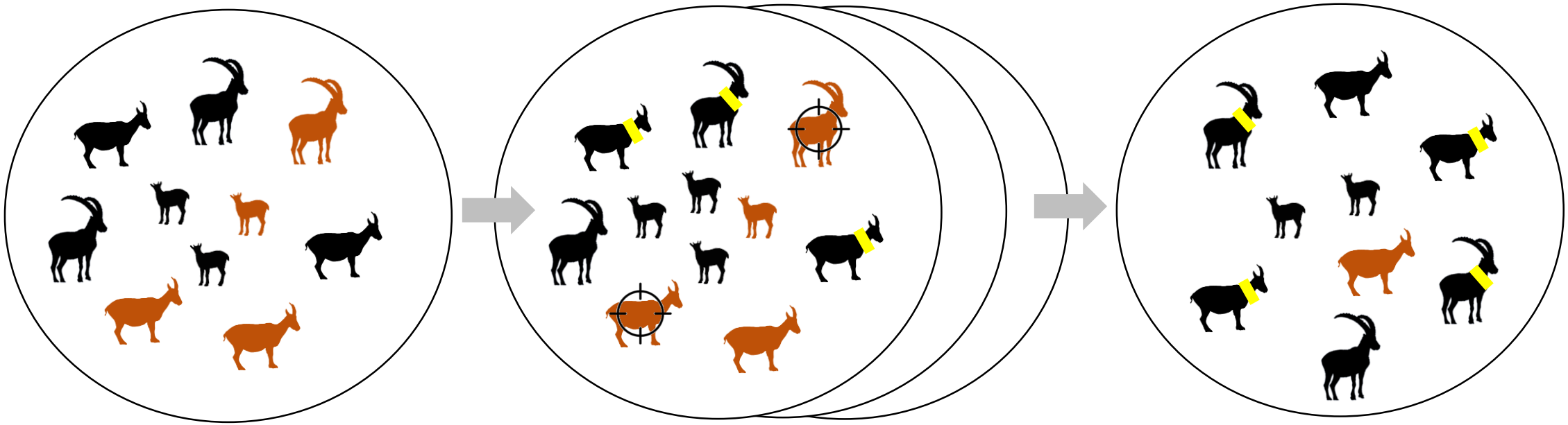


The model

Individual Based Model

Time step = week

Individual state = age, sex, sector & health condition (SEIR)



The model

Unknown parameters to be estimated

Tab = Transmissions risk per infectious abortion and birth

Tv = Venerian transmission risk

K = Carring capacity

→ Maximum population size that can be sustained by the environment

Parameter estimation

ABC method (Approximate Bayesian Computation)

Parameters (Tab, Tv & K) → IBM simulations → **Seroprevalence** **Population size** → Comparison with observations → Distance

Abc package

→ Algorithme « rejection »

Summary statistics

Seroprevalence

Proportion [0;1]

220 estimates
(11 years * 5 sectors * 2 sexes * 2 age-classes)

Robust estimates

Population size

Abundance [0;+inf]

11 estimates
(11 years)

Quite uncertain …

Summary statistics

Seroprevalence

Proportion [0;1]

220 estimates
(11 years * 5 sectors * 2 sexes * 2 age-classes)

Robust estimates

Population size

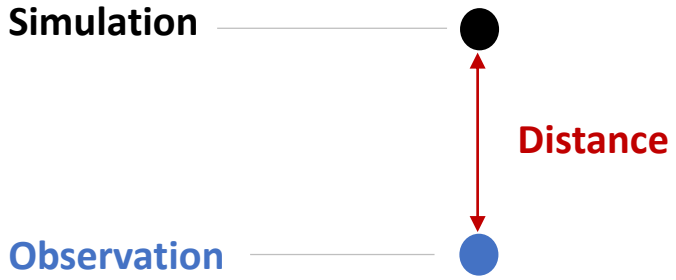
Abundance [0;+inf]

11 estimates
(11 years)

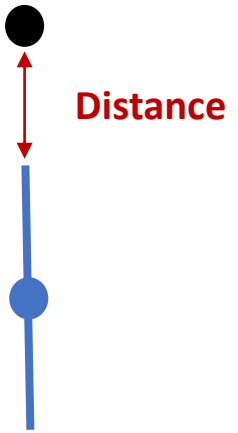
Quite uncertain …

Summary statistics

Seroprevalence = point estimate

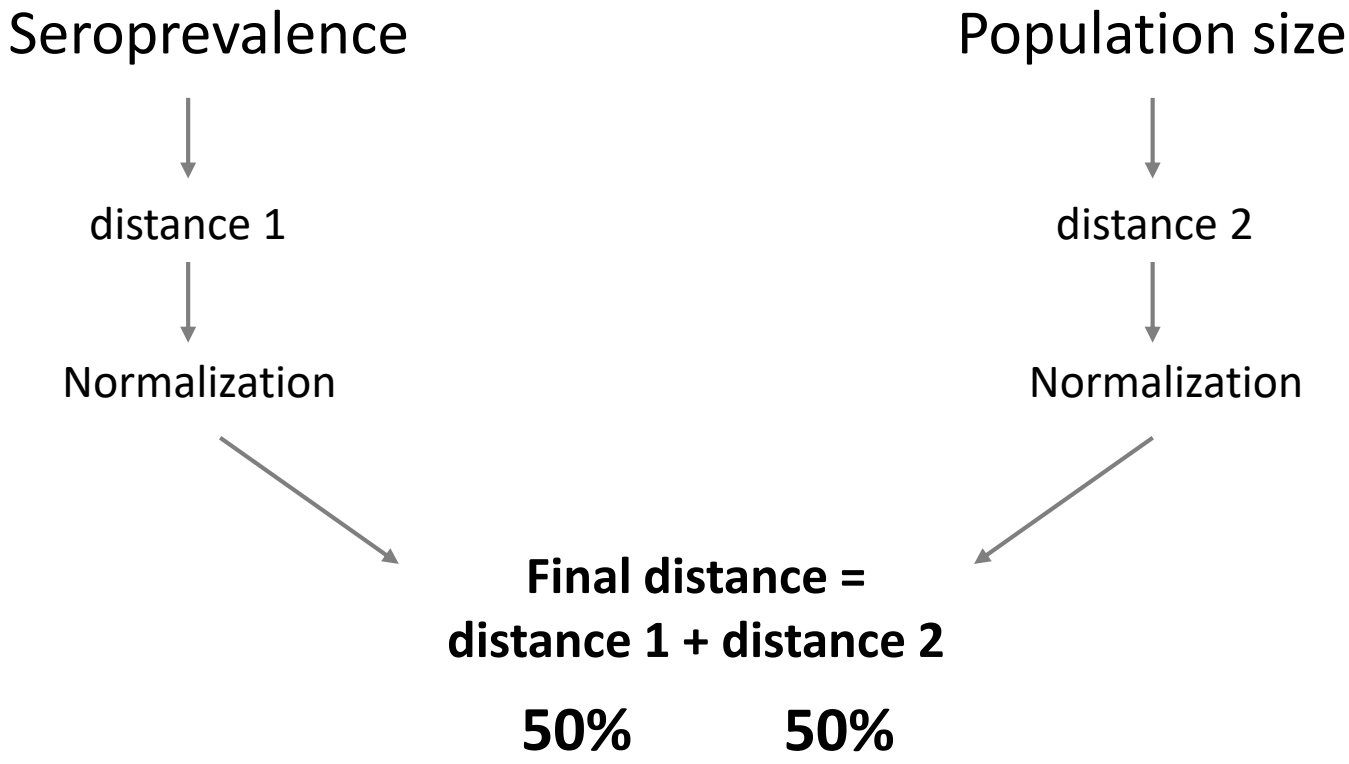


Population size = range

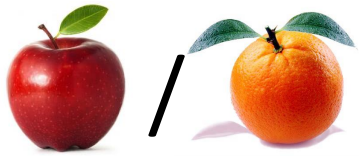


Summary statistics

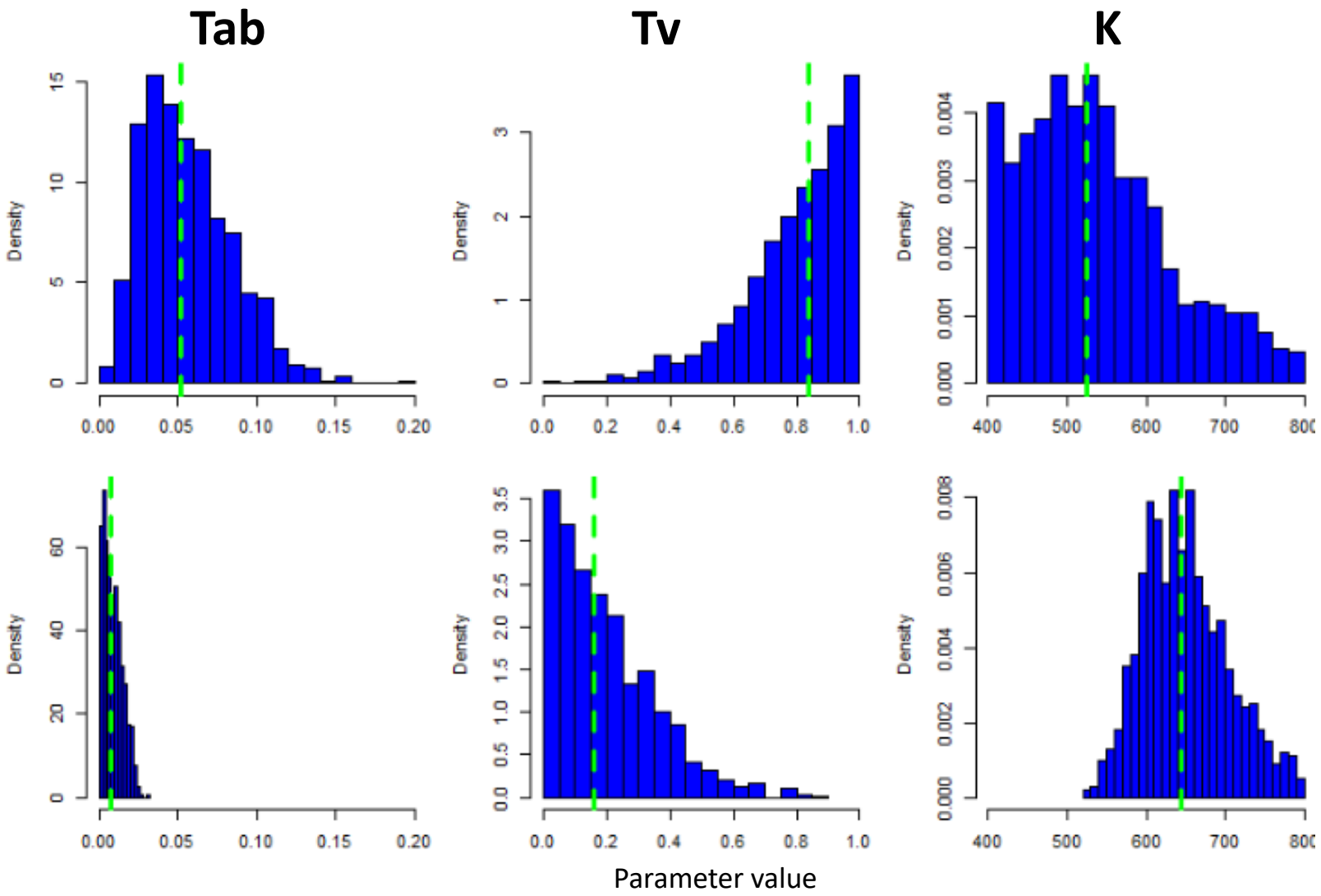
Weight attribution



Summary statistics

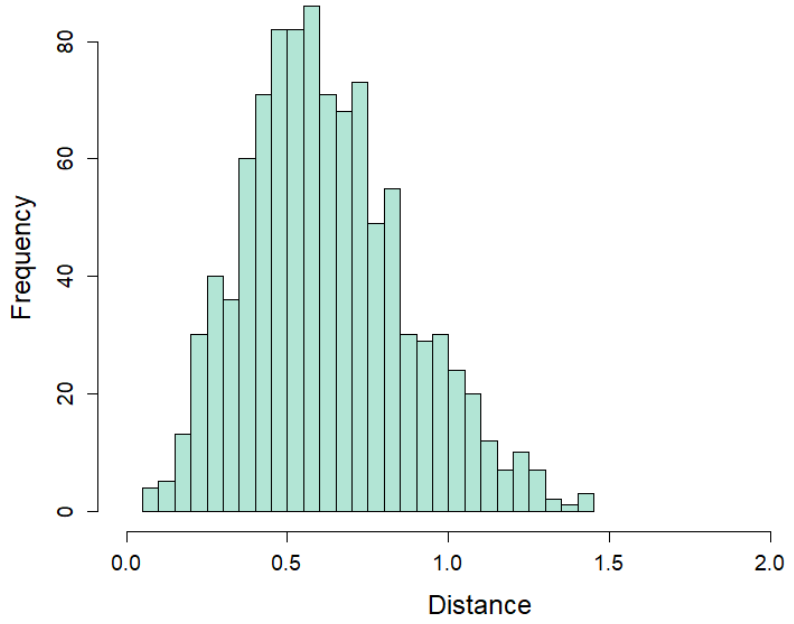


Correction



Distance computation

Uncertainty in distance estimation



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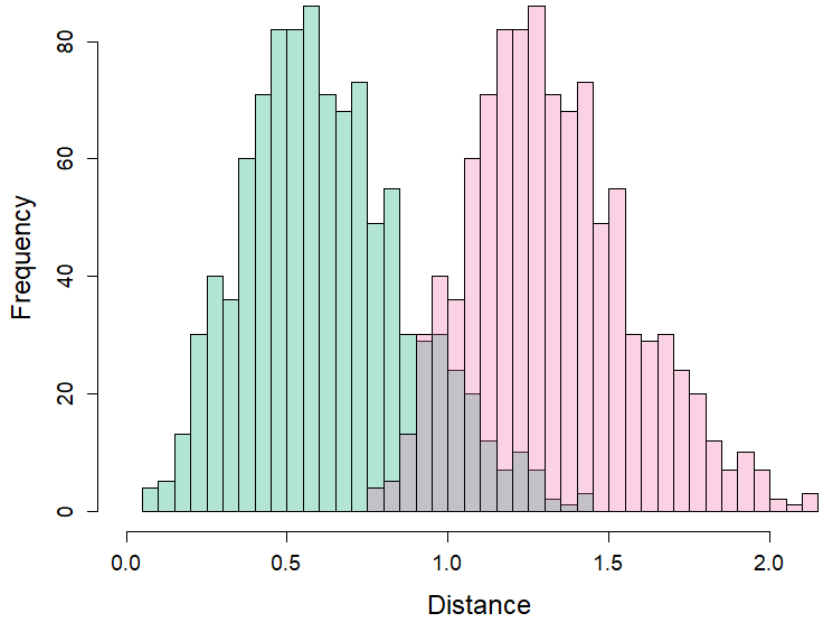
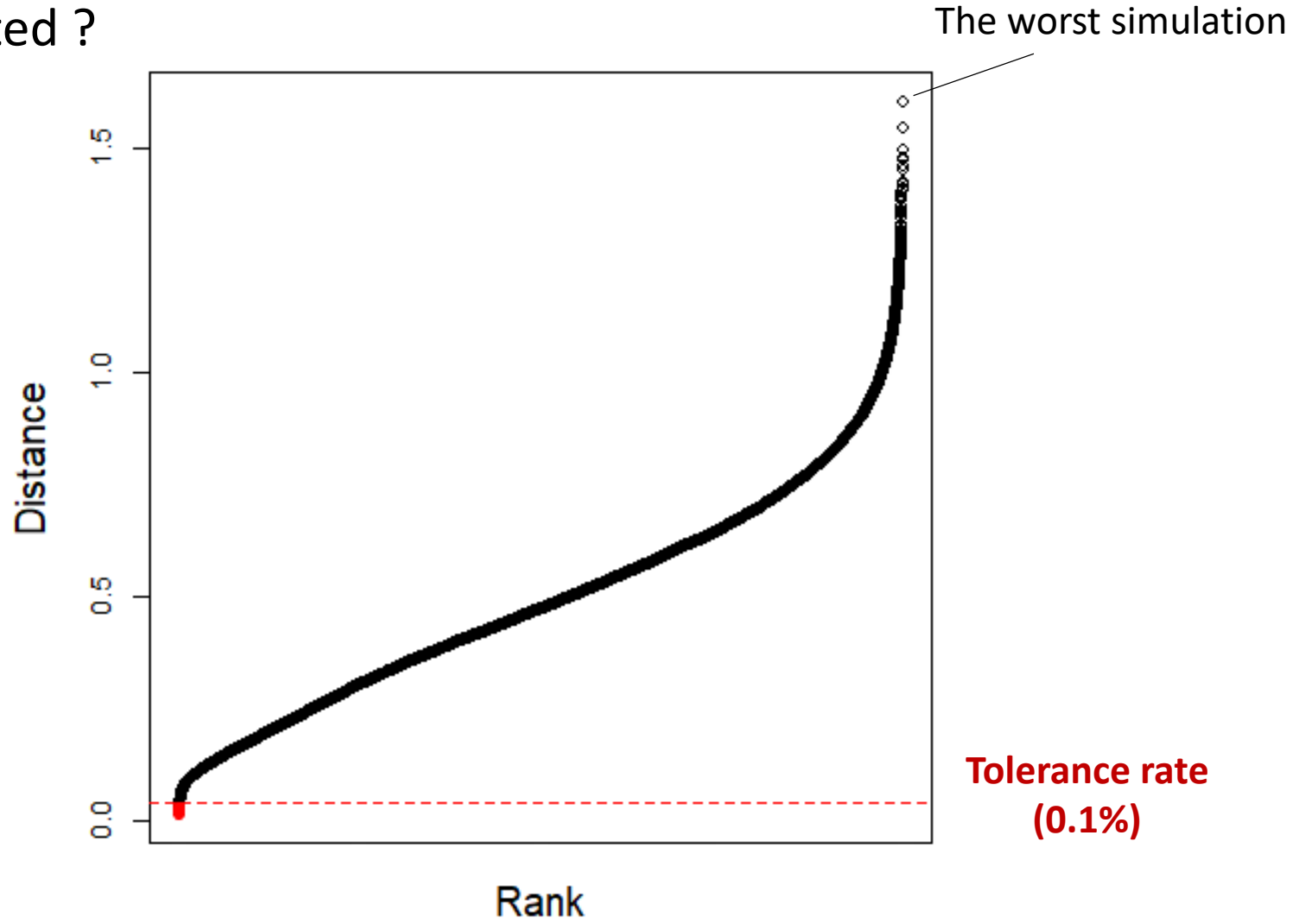


→ Simulation repetitions can improve discrimination between candidate parameters

Distance computation

Which simulations have to be repeated ?



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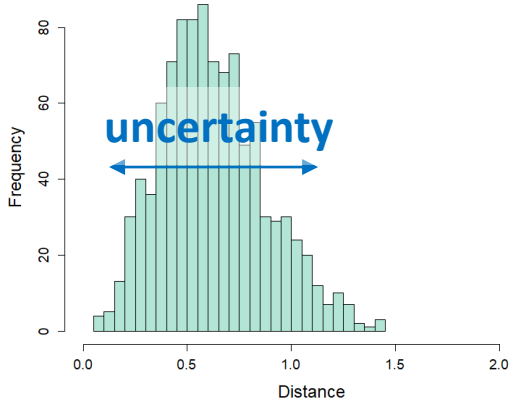
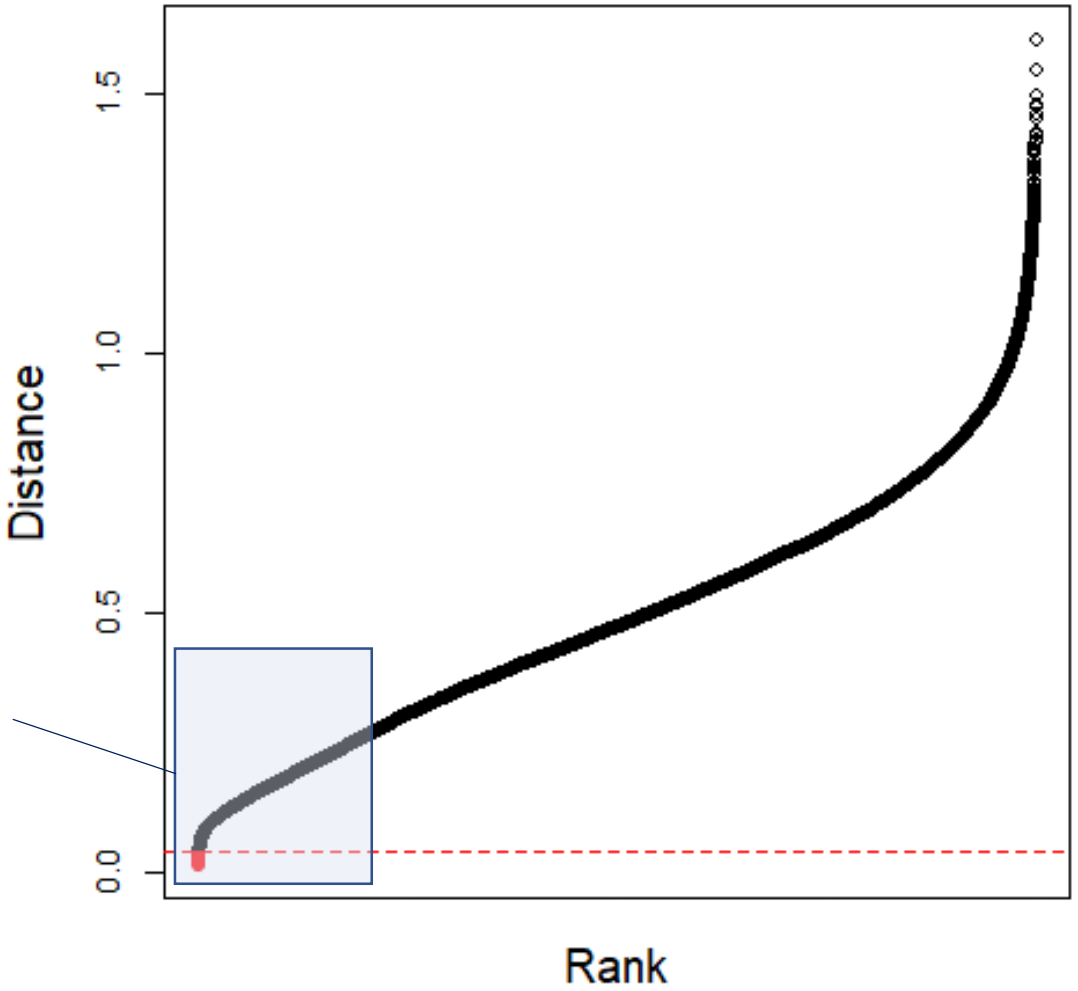


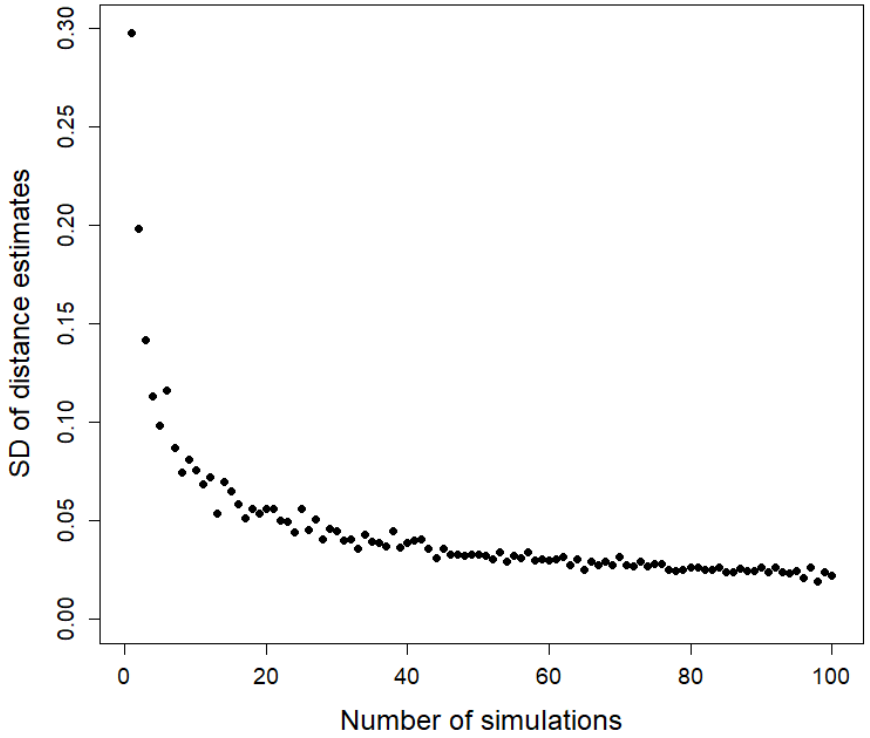


Best simulations area (20%)

Tolerance rate (0.1%)

Distance computation

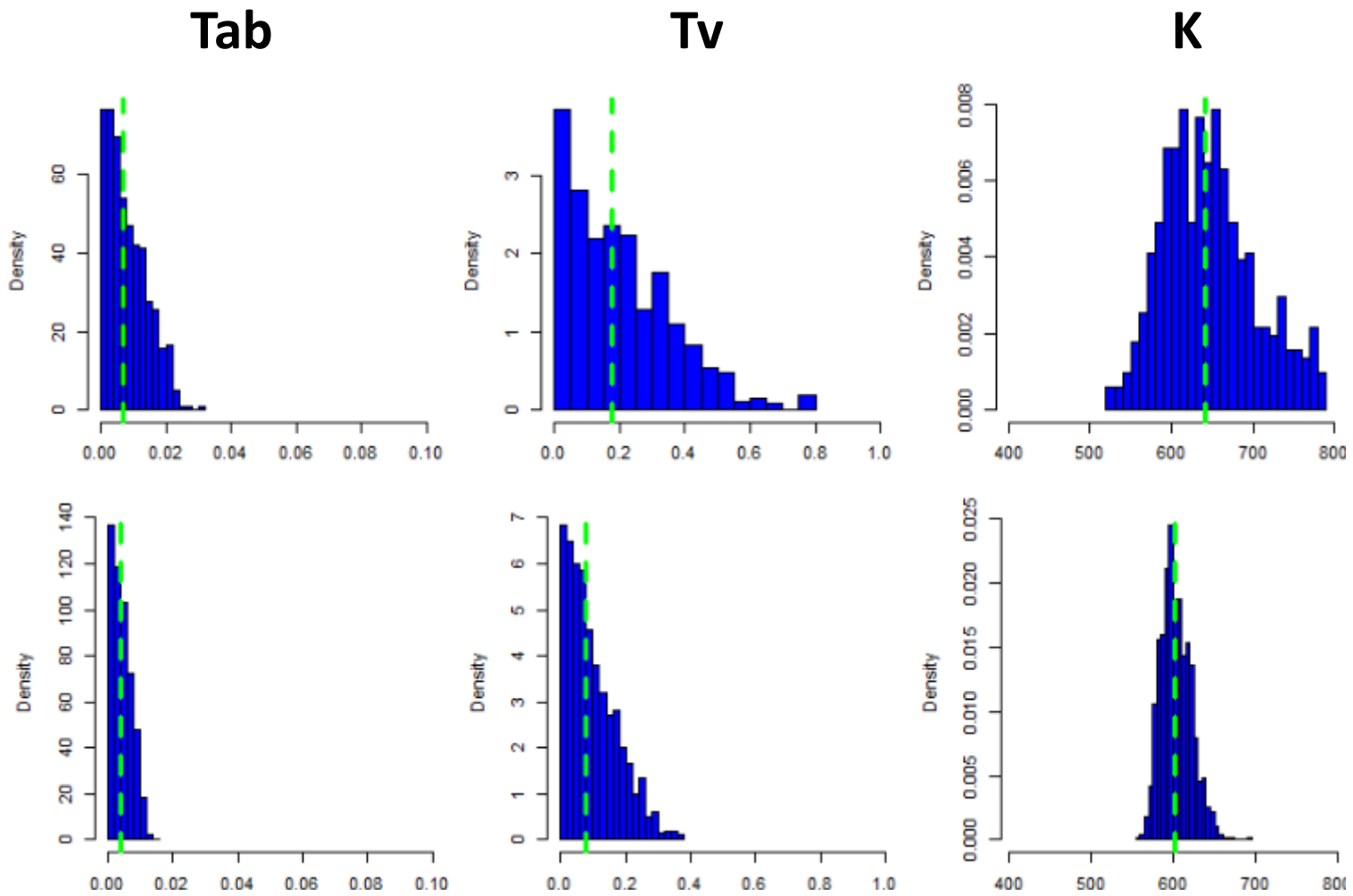
How many repetitions are needed ?



Distance computation

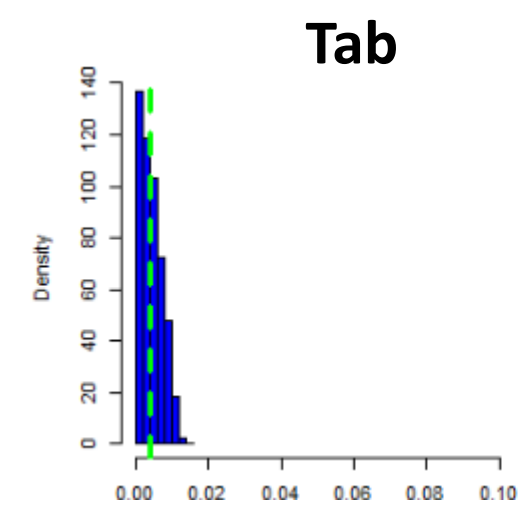
No repetition

20 repetitions

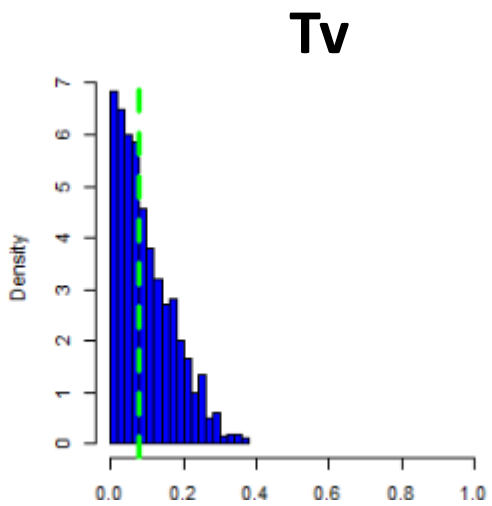


Parameter estimation

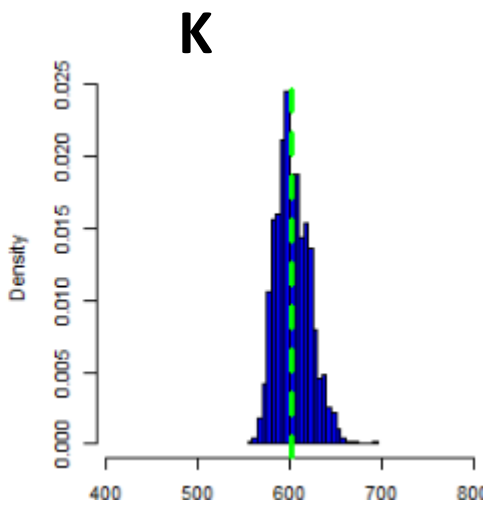
What are the best estimates ?



Median 0.004



0.08



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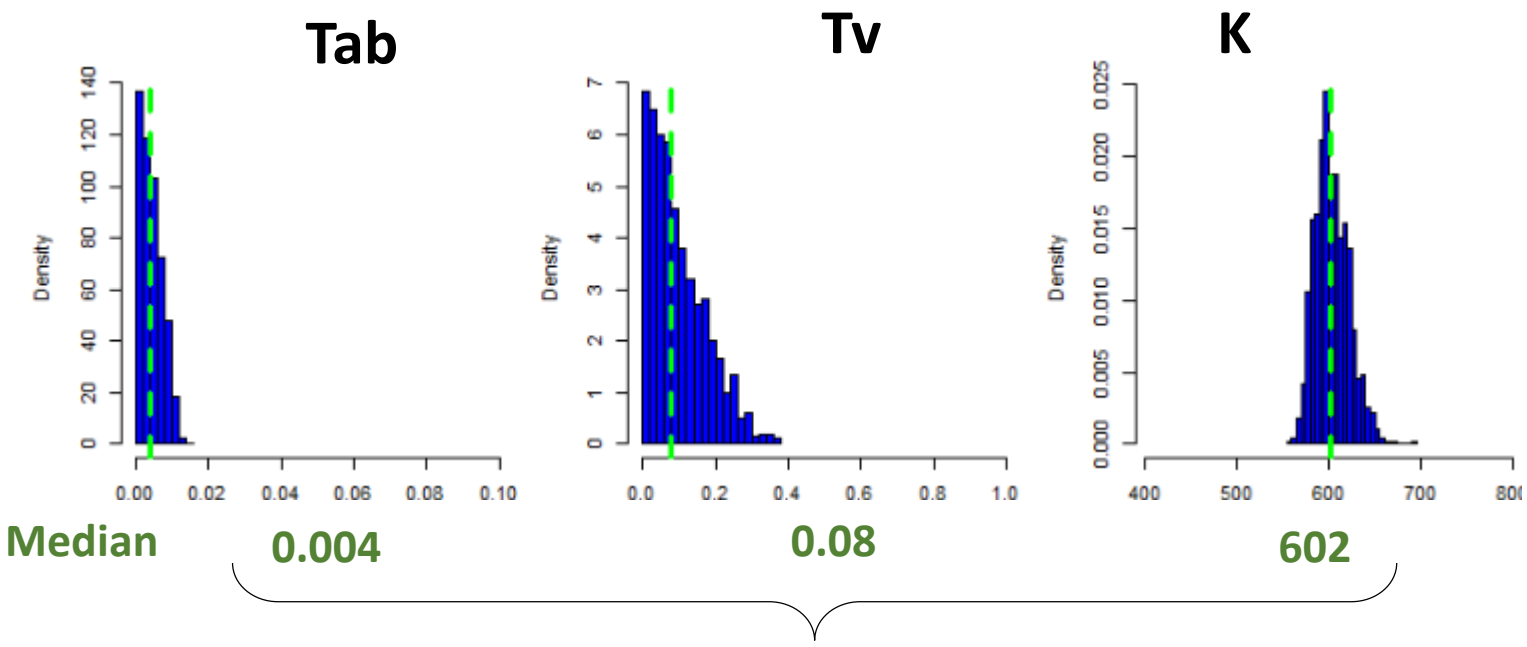
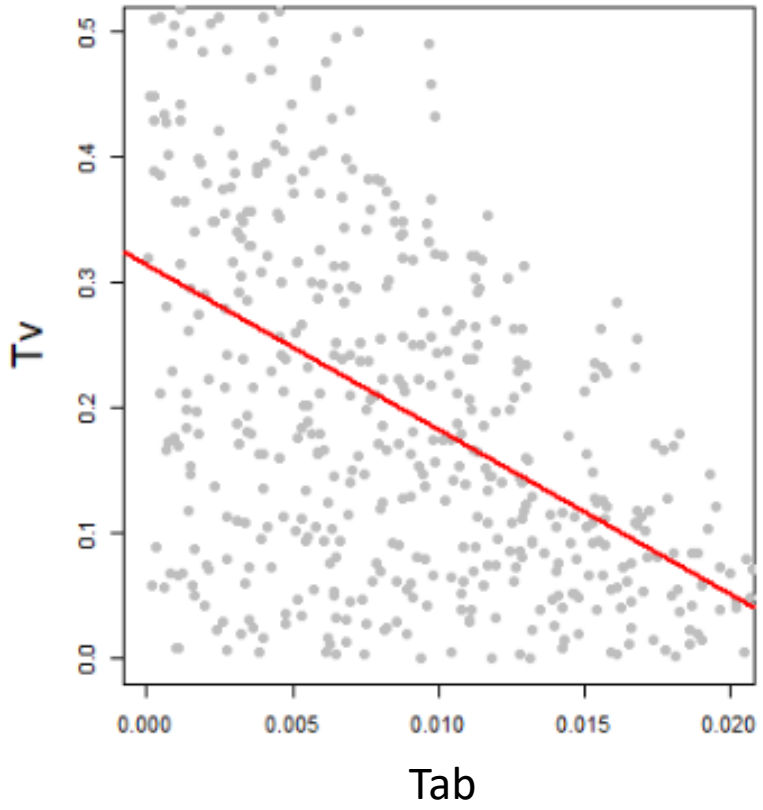
Parameter estimation

What are the best estimates ?



Parameter estimation

What are the best estimates ?



→ Set of candidate parameters in the posterior distribution

Conclusion

ABC: The devil is in the details

- Pay attention to summary statistics definition
- Assess uncertainty in distance estimate
- Point estimate vs. distribution

Conclusion

ABC: The devil is in the details

- Pay attention to summary statistics definition
- Assess uncertainty in distance estimate
- Point estimate vs. distribution

Thank you for your attention !

MINISTÈRE
DE LA TRANSITION
ÉCOLOGIQUE

MINISTÈRE
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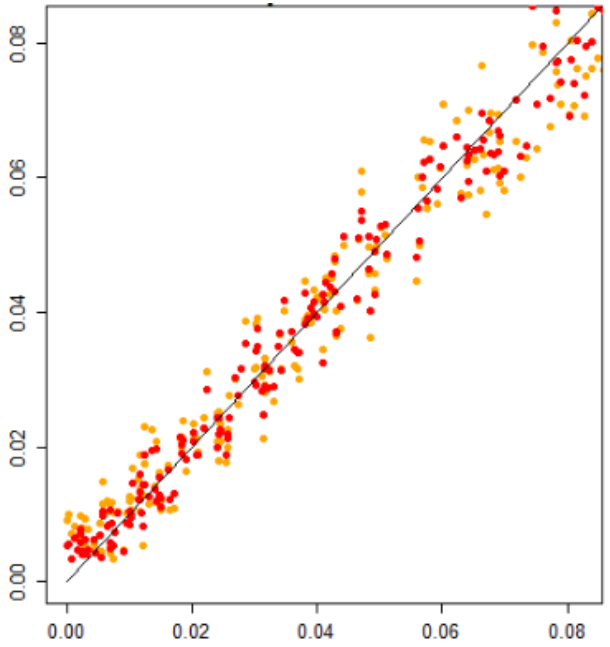
ET DE L'ALIMENTATION

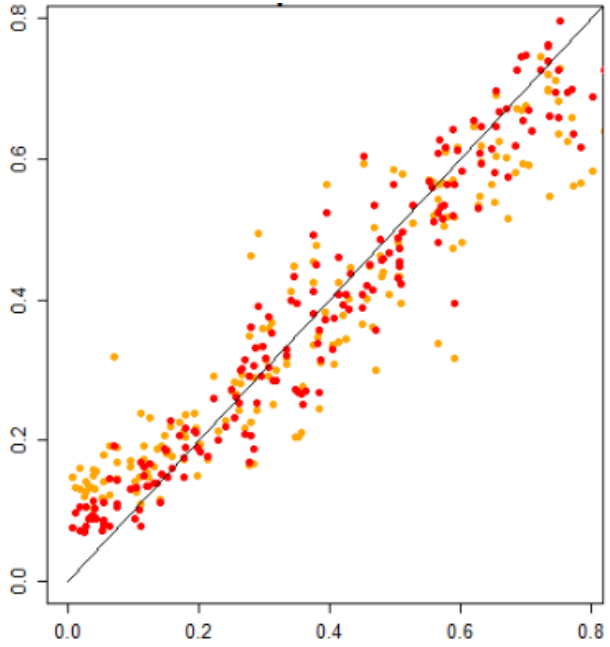
MoDAH 3
Modelling in Animal Health

Cross-validation test

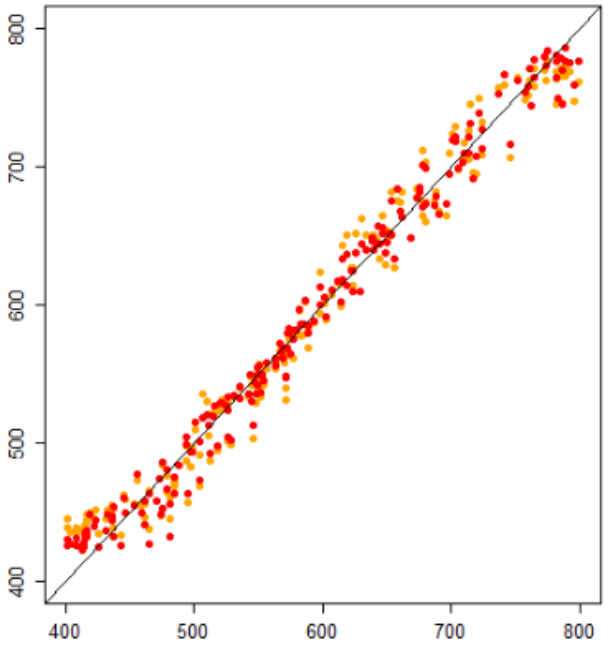
Tab



Tv



K



Fit assessment