abc: an R package for Approximate Bayesian Computation.

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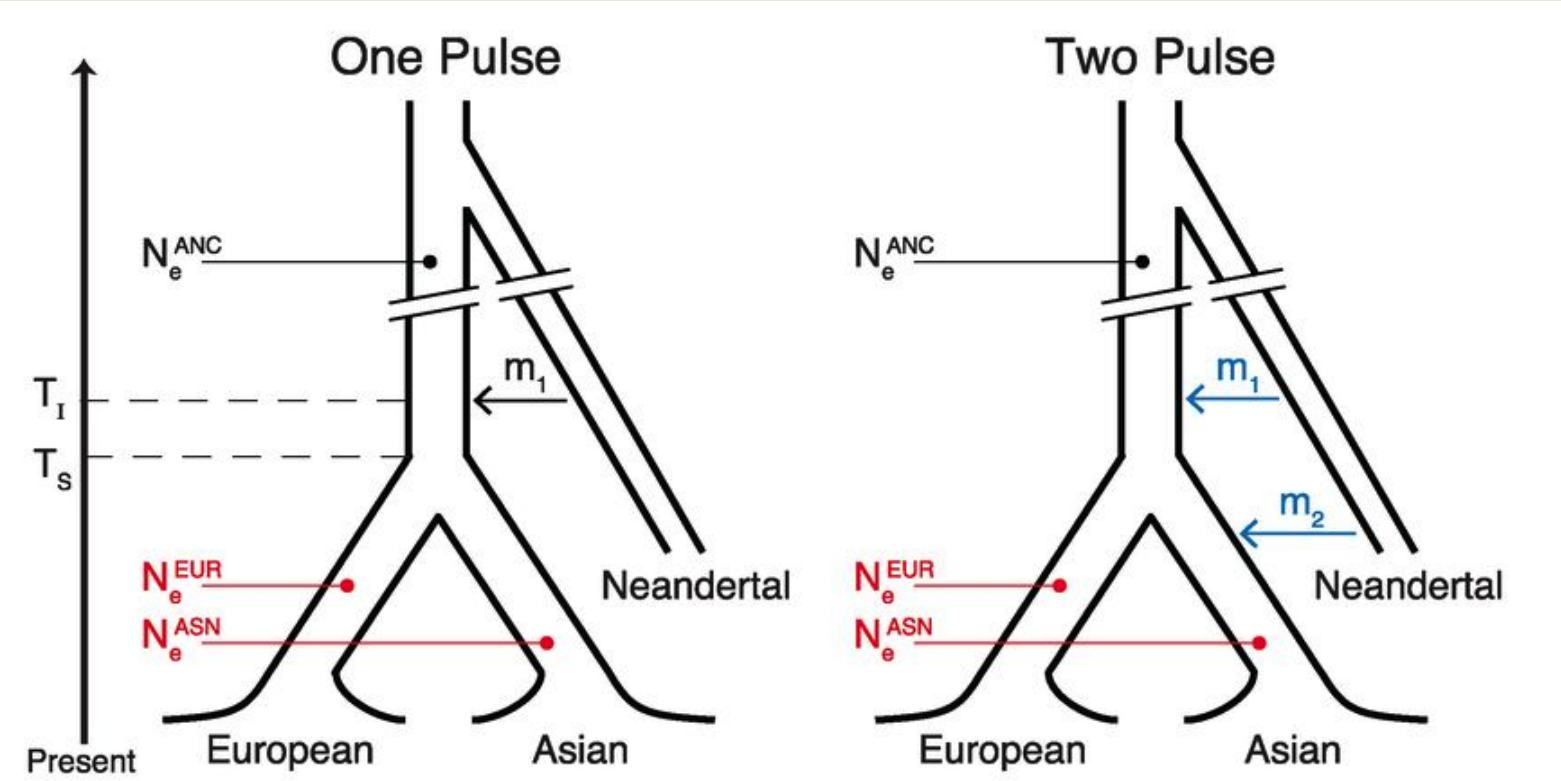
Rencontres R, Grenoble, June 2015

Modeling in science

- ABC is concerned with mechanistic models that aim to mimic the biological or physical processes that are thought to have given rise to the data.
- Mechanistic models are different from phenomenological models that seek only to best describe the data using a statistical model.

`The ecological detective: confronting models with data (Hilborn and Mangel, 1997)`

An example of mechanistic model fitted with ABC

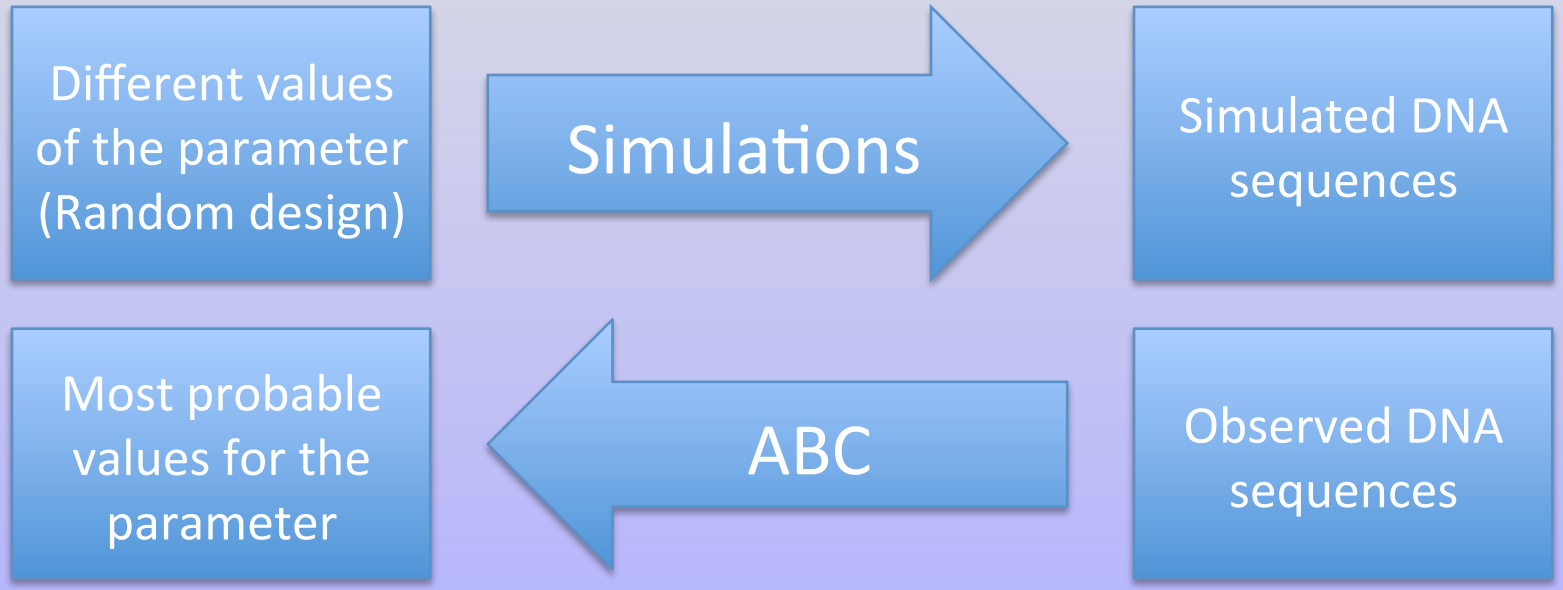


Vernot and Akey, Science 2014

What is ABC ?

"ABC is a 'democratizing' method in that it will attract, for example, biologists, who enjoy computer simulation but have little background in probability, into converting their favorite simulation into a tool for inference"

Beaumont and Rannala, Nat Rev Genet 2004



Two approximations in ABC

- Replace *full posterior* $p(\theta|D)$ with *partial posterior* $p(\theta|\mathbf{s}_{obs})$ where θ is the parameter of interest, D are the data, and $\mathbf{s}_{obs}$ are *summary statistics*.

- Sampling from $p(\theta|\mathbf{s}_{obs})$ is not based on likelihood computations but on numerical simulations.

Rejection algorithm for parameter inference

- Simulate n values θ_i, $i = 1, \ldots, n$ from the prior π
- Simulate n (possibly multivariate) summary statistics $\mathbf{s_i}$ according to $p(\mathbf{s_i}|\theta_i)$
- Accept the simulations for which $d(\mathbf{s}_i, \mathbf{s}_{obs})$ is smaller than a given threshold (d is a distance function).

`Pritchard et al., MBE 1999`

Bayesian data analysis

ABC includes all aspects of Bayesian data analysis.

1. Parameter inference (Posterior distributions).
2. Model comparison (Model Probabilities, Bayes factors).
3. Goodness of fit (Posterior predictive check, Goodness of fit hypothesis testing).

Software and R packages for ABC

Name	R package	Simulations	Comment
abc	Yes	No	Generalist
abctools	Yes	No	Dimension reduction
ABCtoolbox	Yes	No	Generalist
ABC-SysBio	No	Yes	Systems Biology
DIYABC	No	Yes	GUI for Population Geneticists
easyabc	Yes	No	MCMC-ABC
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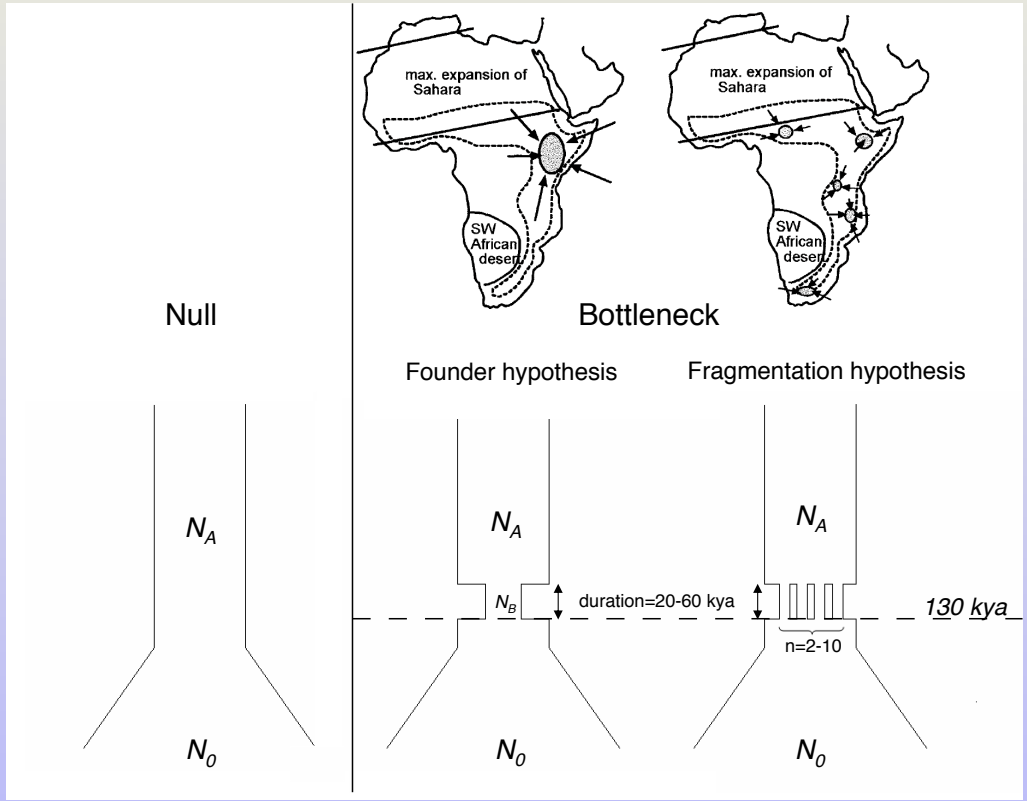
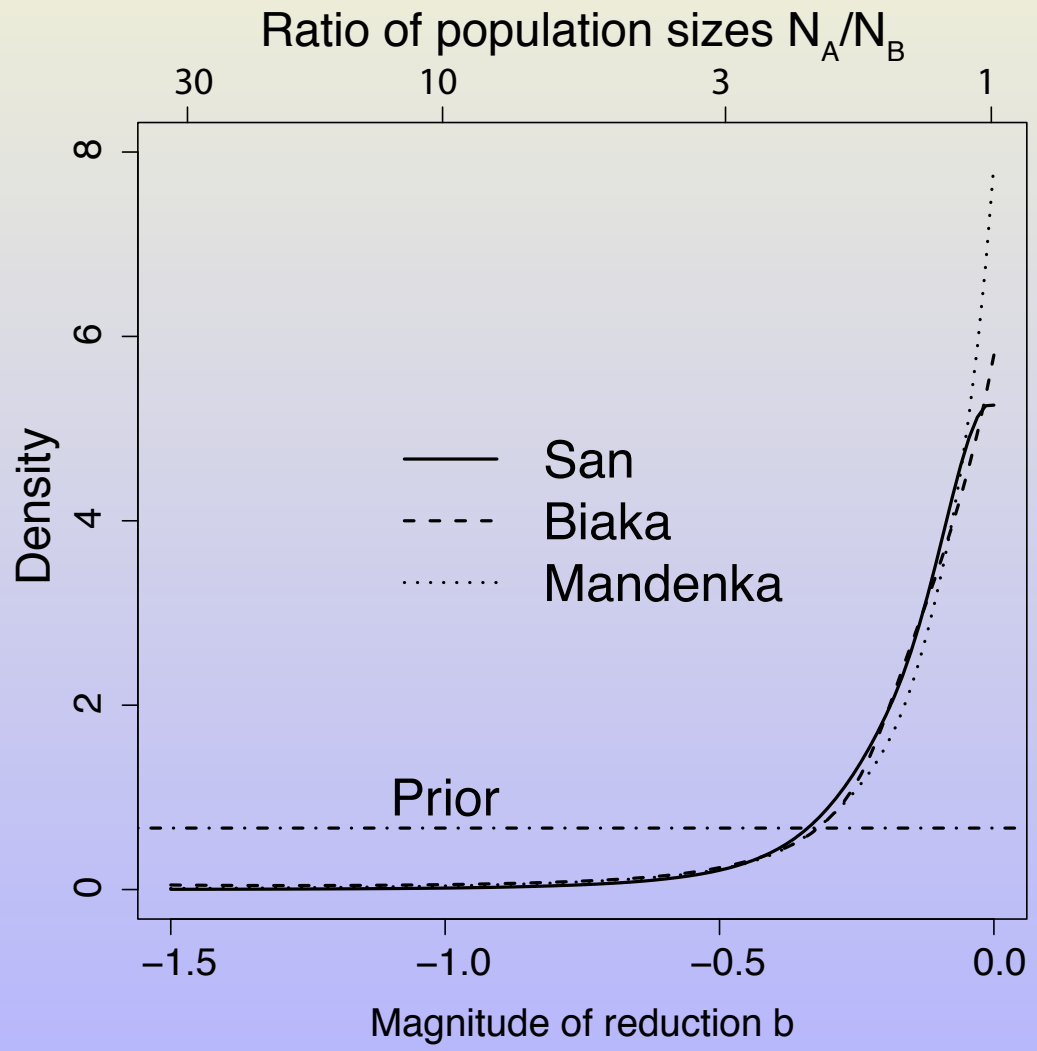
An example of ABC analysis in anthropological genetics

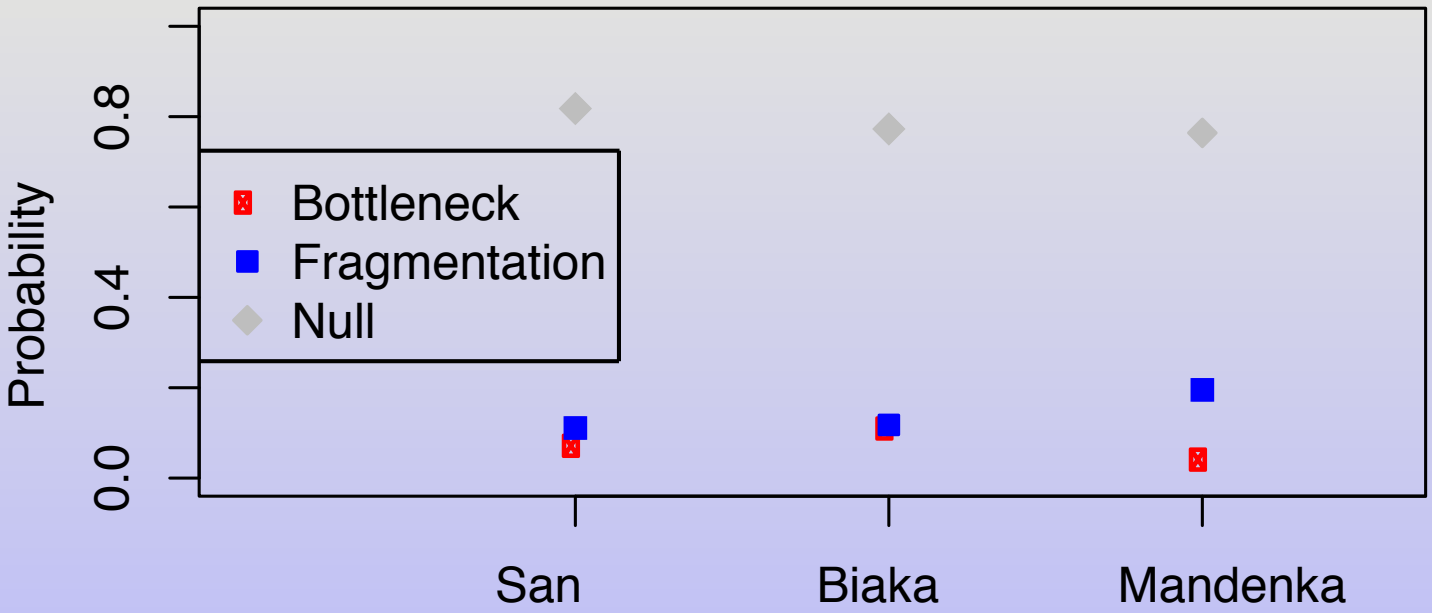


Sjödin et al., MBE 2012

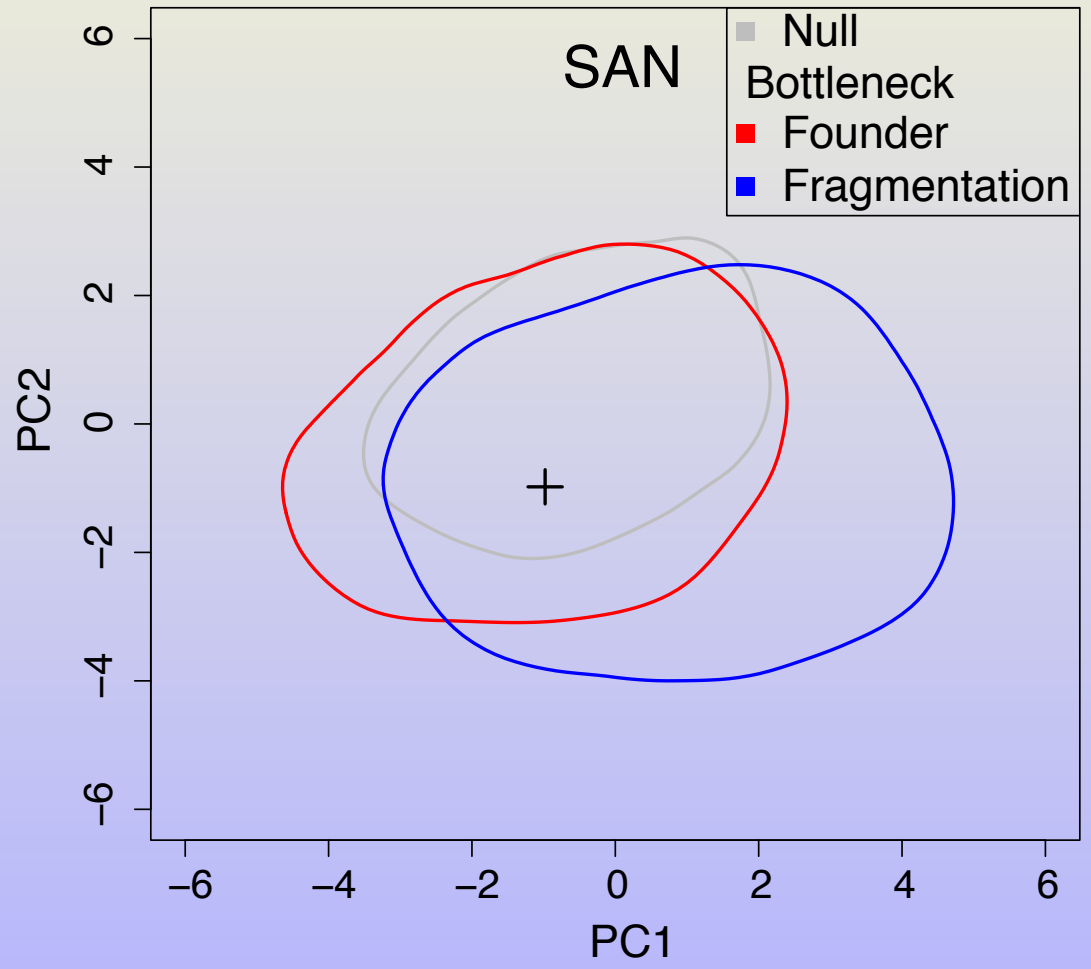
Parameter inference with the *abc* function



Model selection with the *postpr* function



Goodness of fit with the *gfitpca* function



Perspectives

ABC methods, algorithms and software are well established and widely used. New and unforeseen applications will foster methodological developments.