Model fitting and inference for infectious disease dynamics

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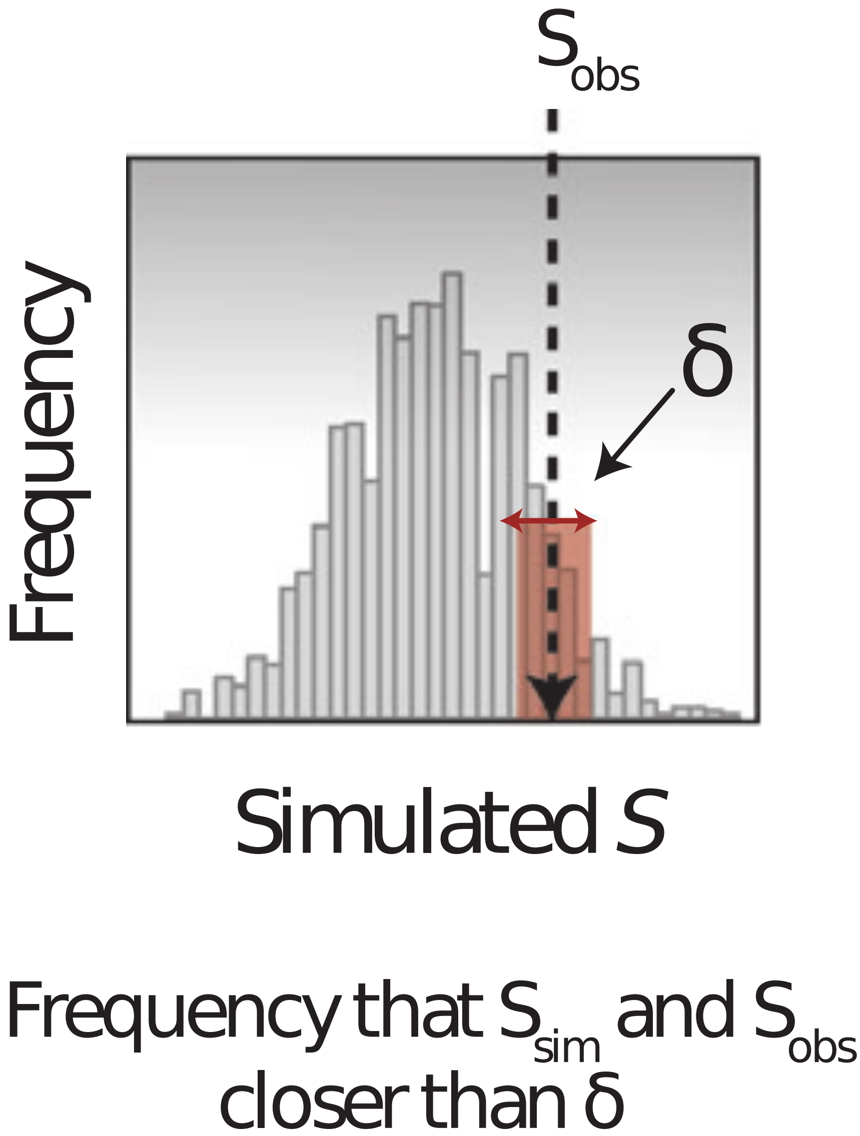
1 Approximate Bayesian Computation

1.1 Motivation

- we want to evaluate $p(\theta|y)$ (posterior) in a stochastic model
- PMCMC:
  - calculate likelihoods $p(y|\theta, x)$ and margnialise over x
- ABC:
  - *approximate* the posterior using summary statistics S
- Summary statistics
  - Something that is *easy* to calculate and approximates the likelihod
  - e.g., final size, number of peaks, height/timing of peaks
  - idea of *sufficient* summary statistics: to be exact, I need summary statistics that give *exactly* the same result as the likelihood

1.2 Idea of ABC



1.3 ABC

1. Choose a summary statistic S, positive number ϵ, distance function $d(S_1, S_2)$
2. Calculate summary statistic for data
3. repeat:
   (a) sample θ from prior $p(\theta)$
   (b) simulate trajectory
   (c) calculate S_{sim}

(d) calculate difference $d(S_{\mathrm{sim}}, S_{\mathrm{data}})$

(e) if $d(S_{\mathrm{sim}}, S_{\mathrm{data}}) < \epsilon$ accept, else reject

4. proportion of accepted runs for any θ approximates $p(\theta|y)$

1.4 ABC-MCMC

1. Choose a summary statistic S, positive number ϵ, distance function $d(S_1, S_2)$ and initial θ

2. Calculate summary statistic for data

3. repeat:

   (a) sample θ^* using transition kernel $q(\theta^*, \theta)$

   (b) simulate trajectory + observation

   (c) calculate S_{sim}

   (d) calculate difference $d(S_{\mathrm{sim}}, S_{\mathrm{data}})$

   (e) if $d(S_{\mathrm{sim}}, S_{\mathrm{data}}) < \epsilon$ accept with probability

   $$\min\left(1, \frac{p(\theta^*)}{p(\theta)} \frac{q(\ldots)}{q(\ldots)}\right)$$

   else reject

4. time spent at any θ approximates $p(\theta|y)$