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Statistical modelling of summary values leads to accurate Approximate Bayesian Computations

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Approximate Bayesian Computations (ABC) are considered to be noisy. We show that ABC can be set up to estimate the mode of the true posterior density exactly, or alternatively provide unbiased estimates of model parameters. Further, ABC can be set up such that the Kullback-Leibler divergence of the ABC approximation to the true posterior density is minimal. The main idea is to construct - through statistical modelling of summary values - an appropriate probability space on which the ABC approximation can be controlled. We consider analytically tractable parametric models for summary values that are parameterised by summary parameters. ABC is reformulated in terms of testing the equivalence of summary parameters with observed and simulated summary values. Summary statistics are implicitly defined through these tests. Since the mathematical properties of testing procedures are well understood, we can understand and adjust the ABC approximation as desired. An example from infectious disease epidemiology using time series data illustrates the general theory in action. This shows that statistical modelling of the observed summary values - the data from an ABC perspective - leads to a well-defined probabilistic framework within which the ABC approximation can be controlled.

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