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Estimating the distribution parameters of harvested stock from assortments via Approximate Bayesian Computation

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Abstract

National forest inventories in Germany are only carried out every ten years, so that the gathered information is aging every year after. Timely improved knowledge about the current state of the forest regarding standing stock is of high value. With that, one can make more precise statements about the carbon stored and potential future harvest. Also, with the knowledge of the harvested stock, estimates of biomass and nutrition export are possible.
The aim of this study is, therefore, to estimate the harvested stock, (i.e. the number of trees and the distribution of diameter at breast height (dbh) and height) from assortments, which are regularly recorded during harvest operations.
While the harvesting process is a complex interaction between the selected trees, the rules for cutting and the practice of the foresters, harvesting operations can be carried out with a strong manual focus to a highly automated process with harvesting machines (harvester). While manually harvest can produce and reflect very special assortments, harvesters are used to efficiently produce high volumes of mostly uniform assortments.
Here, methodologies and results regarding cuttings by harvesters will be shown because this process is less complex and, therefore, more suited to test the applicability of the ABC framework. The choice to use ABC in this context, can be justified by the fact, that harvesting can be considered as an stochastic process, of which not all relevant parameters are recorded nor can be observed. The ABC is carried out by using Rejection Sampling. Although this algorithm does not sample from the posterior distribution, it can be recycled to predict parameters of more than one observation, which is a relevant fact with regard to thousands of observations that are gathered during past and future harvest operations.
The choice of a summary statistics is limited by the recordings of the assortments. These mainly comprise information about length, mid diameter, number of pieces and total volume. Several distance measures, including euclidian distance between simple descriptive measures like mean and standard deviation but also more complex metrics like histogram comparison techniques (χ^2, Quadratic Form, Earth Mover's Distance), are tested as potential distances between the summary statistics of the observation and simulation.
As there are virtually no data sets comprising information about the harvested stock and the produced assortments thereof, it is necessary to use simulation techniques to quantify the precision of the ABC-estimates in relation to dbh and heigth but also to evaluate the performance of the summary statistics.