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Reforging the Wedding Ring: Exploring a Semi-Artificial Model of Population for the United Kingdom with Gaussian process emulators

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Abstract

Background: We extend the "Wedding Ring" agent-based model of marriage formation to include some empirical information on the natural population change for the United Kingdom together with behavioural explanations that drive the observed nuptiality trends.

Objective: We propose a method to explore statistical properties of agent-based demographic models. By coupling rule-based explanations driving the agent-based model with observed data we wish to bring agent-based modelling and demographic analysis closer together.

Methods: We present a Semi-Artificial Model of Population, which aims to bridge demographic micro-simulation and agent-based traditions. We then utilise a Gaussian process emulator - a statistical model of the base model - to analyse the impact of selected model parameters on two key model outputs: population size and share of married agents. A sensitivity analysis is attempted, aiming to assess the relative importance of different inputs.

Results: The resulting multi-state model of population dynamics has enhanced predictive capacity as compared to the original specification of the Wedding Ring, but there are some trade-offs between the outputs considered. The sensitivity analysis allows identification of the most important parameters in the modelled marriage formation process.

Conclusions: The proposed methods allow for generating coherent, multi-level agent-based scenarios aligned with some aspects of empirical demographic reality. Emulators permit a statistical analysis of their properties and help select plausible parameter values.

Comments: Given non-linearities in agent-based models such as the Wedding Ring, and the presence of feedback loops, the uncertainty in the model may not be directly computable by using traditional statistical methods. The use of statistical emulators offers a way forward.

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