A Bayesian Melding Approach for Stochastic Agent-Based Models

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Abstract:
Mathematical models are widely employed across scientific disciplines, especially when field data are sparse. Where field data are available, they are often used informally as "ground truth" for model calibration. Formal incorporation of theoretical relationships with data via the likelihood can be formulated as, say, a state-space model that gives rise to a well-defined likelihood, or a black-box model that renders the likelihood intractable. In contrast, Bayesian melding (Poole & Raftery, 2000 in JASA) regards the theoretical model (black-box or otherwise) as part of the prior distribution, formulated as the "melded prior". Literature on Bayesian melding is well-established for deterministic mathematical models. For the stochastic case, such as some agent-based models, formal derivation of the melded prior had been lacking. We propose a solution and apply it to an existing stochastic agent-based model. To allow flexible formulations of likelihoods without sacrificing computational efficiency, we employ an emulator alongside a posterior sampling algorithm that embeds sampling importance-resampling within Metropolis-Hastings. The bulk of this joint work (in progress) appears in Dawkins (2017) (ANU Honours Thesis co-supervised by G. Chiu and A. Westveld).

Keywords:
Bayesian melding; stochastic models; agent-based models; emulators; bees