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Parameter Estimation and Forecasting for Biased Models

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Traditionally, parameters of dynamical systems are estimated by directly comparing model simulations to observed data utilizing a least squares approach. However, if the models are biased, this classical approach may not accurately estimate the true states. Here, a data-driven approach is proposed that enables the model to follow the trajectory of the data. More so, following this approach, the model parameters can be adjusted in the process. The simple Ross model for malaria is used as an example, as it does not capture the impact of external factors, such as periodically changing weather patterns. A hybrid of state-augmentation and Kalman filter (KF) likelihood methods are applied to estimate both the dynamic and static parameters of the model. Data such as the monthly hospital cases from Nigeria, as well as rainfall in the same region, are utilized as a proxy in order to help the filter to produce an optimal estimate of the evolving state of the system. The idea is that the model bias translates to the parameters, in the sense that the right parameters can be estimated but with larger uncertainties. Markov Chain Monte Carlo (MCMC) is employed as a general tool to diagnose the identifiability of the static parameters. We outline some integral steps to handle model bias using KF likelihood. Examples for hospital planning are discussed: how to anticipate and prepare for potential increases in patient volume during and after periods of rainy seasons.

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