Doing statistics with dynamics: Bayesian inference and applications for Markov and semi-Markov processes

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Discrete state-space Markov and semi-Markov processes are used to model a wide range of applications, for example in epidemiology and many areas of population and behavioural ecology. These models are expressed in terms of key processes and the rates at which they occur, and therefore provide a natural representation of expert knowledge about such systems. However, typically model parameters are not known precisely and particular mechanisms may be disputed. Fortunately, in recent years a range of methods associated with data-augmented Markov chain Monte Carlo (MCMC) have been developed to enable Bayesian inference for such models based on noisy and incomplete observational data. In this talk I will outline this methodology and describe some novel developments including model-based-proposals for improved MCMC sampling of the posterior, and the use of latent-residuals for assessing model components. These will be illustrated with a range of applications such as the study of wildlife disease systems, inference of genetic effects, the spread of invasive aliens across a landscape, and disease transmission between farms.