Bayesian Robustness
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MODELLING AND ROBUSTNESS ISSUES IN BAYESIAN TIME SERIES ANALYSIS[1]

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Abstract. Some areas of recent development and current interest in time series are noted, with some discussion of Bayesian modelling efforts motivated by substantial practical problems. The areas include non-linear auto-regressive time series modelling, measurement error structures in state-space modelling of time series, and issues of timing uncertainties and time deformations. Some discussion of the needs and opportunities for work on non/semi-parametric models and robustness issues is given in each context.

1. Introduction. Three areas of recent development and current interest in Bayesian time series analysis are: non- or semi-parametric models for non-linear auto-regressions, and related time series structures, based on mixture models; the modelling and accommodation of measurement errors in state space models; and timing errors, uncertainties, and the use of time deformations to map linear time series models to practically interesting non-linear forms. Methodological developments in each area are made possible through the use of MCMC simulation methods, and we are likely to see growth in application of these, and related, kinds of models for this reason (if no other). Needs and opportunities for theoretical and empirical robustness and sensitivity studies are apparent and, in the light of the preceding comment, very practically desirable. It is hoped that this paper will stimulate some time series research interest among some members of the Bayesian robustness communities. In contrast to much of the growth in the "official" Bayesian robustness field, the majority of the practically interesting robustness issues raised here have to do with the forms of data models and likelihood functions, rather than priors (though the distinction is not always clear-cut).

The discussions below are all based in the context of a real-valued, scalar time series y_t, observed over a specified discrete time interval $t = 1, \ldots, n$. For any time point t, y^t denotes the first t observed values $y^t = \{y_1, \ldots, y_t\}$; for any fixed $p < t$, y_p^t denotes the most recent p values, $y_p^t = \{y_{t-p+1}, \ldots, y_t\}$.

2. Non-linear auto-regression. Non-linear time series has been a growth area in non-Bayesian statistics for over fifteen years, with interest generally focussed on non-linear auto-regressions (e.g. Tong 1990 and references therein). Though there is much Bayesian work in non-linear and non-stationary modelling, only recently have Bayesians really taken up the

[1] *Keywords:* Mixture models; Non-normal time series; Non-linear auto-regressions; Non-parametric Bayesian models; Time series outliers; Time deformations; Timing uncertainties.