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"A Perturbation Approximation to Nonlinear State Space Models"

Markovian state variables are an important feature of many dynamic models. Oftentimes those variables are latent and the researcher (e.g. an econometrician or a decision maker) has to filter them. Nonlinear filtering---that is the computation of the conditional distribution of a latent state vector given the available information---is generally an infinite dimensional problem for which no closed form solutions exist. This paper uses the perturbation method to derive an approximate filter for nonlinear state space models which are not necessarily Gaussian. Key features of the proposed approximate filter are: (1) it is finite dimensional which reduces the dimension of the problem; (2) it is characterized by a finite number of sufficient statistics that are Markovian; (3) as in the case of Kalman filter, the equations governing the dynamics of the sufficient statistics are available in closed form, which makes the computation fast and straightforward; (4) the number of sufficient statistics increases linearly with the order of the approximation. Explicit formulas are derived for stochastic volatility models.