SEQUENTIAL MONTE CARLO METHODS IN R

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Sequential Monte Carlo (SMC) methods, also known as particle filters, are an efficient means for tracking and forecasting dynamical systems subject to both process and observation noise. Applications include robot tracking, video or audio analysis, and general time series analysis.

Whereas the traditional Kalman filter is the optimal way of solving the tracking problem for linear, Gaussian models, other techniques such as SMC methods are needed in the nonlinear or non-Gaussian case. SMC methods maintain a set of particles to represent the posterior at time $t-1$ and then updates the weights of these particles to time step t by taking into account the observation y_t. To avoid an adverse increase in the variance of the importance weights, resampling steps are then usually carried out at regular intervals.

R's functionality provides an excellent basis for the development of flexible and efficient particle filter algorithms, and we show that it is possible to implement a number of interesting time series models, e.g., stochastic volatility models and adaptive factor models. We then demonstrate their use through examples involving real-world, financial, multivariate time series, where particle filter algorithms are used to track underlying factors. We also briefly describe how to use R's built-in optimization procedures to estimate fixed parameters.

We hope to include the developed algorithms and models in a forthcoming R package which will allow the user, through a simple interface, to choose between different approaches, e.g. sampling importance resampling (SIR), auxiliary particle filters (APF) and various resampling strategies.

References

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Date: February 27, 2006.