



Belief propagation for inference in linear-Gaussian models with applications in hydrology

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This contribution considers models consisting of a large number of variables, constrained by a combination of linear deterministic relations, representing physical knowledge of the system, and Gaussian probabilistic relations, accounting for lack of knowledge and noisy observations. Bayesian inference in such models is challenging due to the dimensionality of the joint posterior distribution. An algorithm known as belief propagation allows computation of marginal posteriors in an efficient way that exploits structure and sparseness in the model. Within the context of the linear-Gaussian models considered here, the algorithm can be seen as an extension of deterministic sparse linear algebra methods to probabilistic settings where uncertainty quantification via posterior variances is desired. A version of belief propagation is described and applied to two hydrological case studies that can be formulated as linear-Gaussian models, namely flow accumulation in large drainage networks and two-dimensional groundwater flow.

Keywords: graphical models; clique tree; drainage network; Kalman smoothing.