Joint Estimation of Gaussian and Multinomial States

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The present work is devoted to the joint estimation of mixed-type (continuous and discrete-valued) state variables. This problem is often solved via stochastic approximations used sampling methods (such as particle filters). However, exploitation of particle filters is rather expensive in a computational sense and often require large capacity of data sets. It can be unsuitable to a range of application areas. The present paper considers an entry-wise approach to Bayesian filtering. With its help the joint mixed-type state filtering is solved with an easy computational approximation of the posterior probability density function. In case of independent continuous and discrete data the solution is quite analytically tractable.

The main advantage of the proposed entry-wise approach is a possibility to consider entries of the state vector described by different models. The present work describes a special case with some restrictions: a discrete-valued entry should be placed at the end of the state vector. Extension of the proposed filtering up to the general non-restricted form of the vector is planned to be presented later.

General probabilistic solution is proposed as the filtering, which provides the estimates of entries of a state vector, updated entry-wise. The state-space model is factorized via the chain rule.

Specialization to a series of models was necessary before application of the filtering to the mixed data. For continuous variables and linear Gaussian models the entry-wise updating of the state estimate is reached with the help of decomposition of precision matrices. The proposed factorized version of Kalman filter covers the state estimation in this case. An analytically tractable filtering with a discrete state-space model is shown for multinomial distribution. The joint filtering of mixed states combines both algorithms with approximation of a posterior pdf via minimization of the Kerridge inaccuracy. Illustrative experiments demonstrate application of the filtering to simulated traffic control data.

References

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