A Verified MATLAB Implementation of Markov Set-Chains

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Abstract

One central task in engineering is the accurate identification of system states, for example, those of a nuclear power plant. In probabilistic theory, Markov chains [5] are employed to model system's behavior. However their use is limited for systems with uncertainty because of their deterministic transition matrices. Moreover, their accuracy might suffer due to implementations on computers with finite arithmetics. Our goal is to extend the Dempster-Shafer with Intervals (DSI) toolbox first introduced in [1] for MATLAB with novel verified algorithms to model and to work with Markov chains with imprecise transition matrixes, known as Markov Set-Chains (MSC) [2].

The theory of MSC extends Markov chains by defining an uncertain transition matrix. Based on this introduction of uncertainty into the model, it is possible to describe the system's operation time and environmental influences. Furthermore, the use of verified algorithms copes with the limits of floating point arithmetic. Such algorithms provide an enclosure which is guaranteed to contain the exact result. To obtain such exact result we use INTLAB [3], a MATLAB toolbox for reliable computing.

Our contribution is structured as follows. First, we review the DSI toolbox, the aim of which is to provide verified results and handle uncertainty using Dempster-Shafer theory [4]. In a second step, we consider the benefits of the verified implementation of MSC. We conclude our contribution by illustrating the functionality of our new MSC implementation using a close-to-life example.

Keywords. Dempster-Shafer theory, MATLAB, INTLAB, interval analysis, Markov Set-Chain, DSI

References

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