Fuzziness and Bayesian Analysis in Engineering

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In engineering situations, we usually have a large amount of prior knowledge that needs to be taken into account when processing data. Traditionally, the Bayesian approach is used to process data in the presence of prior knowledge. Sometimes, when we apply the traditional Bayesian techniques to engineering data, we get inconsistencies between the data and prior knowledge. These inconsistencies are usually caused by the fact that in the traditional approach, we assume that we know the exact sample values, that the prior distribution is exactly known, etc. In reality, the data is imprecise due to measurement errors, the prior knowledge is only approximately known, etc. So, a natural way to deal with the seemingly inconsistent information is to take this imprecision into account in the Bayesian approach – e.g., by using fuzzy techniques. In this paper, we describe several possible scenarios for fuzzifying the Bayesian approach in an engineering context.

In this paper, we investigate how imprecision from different sources is propagated through the Bayesian update and mapped to results relevant in engineering analyses. To implement the corresponding fuzzy versions of the Bayesian formulas, we use straightforward computations of the related expressions. This allows an investigation of the dependability problem and the consideration of possible simplifications for numerically efficient engineering applications.

Key Words: Fuzzy-Bayes, imprecise data, uncertainty quantification, imprecise probabilities, fuzzy random variables

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The presented work has been developed within a research project in National University of Singapore in collaboration with the University of Texas at El Paso. The authors gratefully acknowledge the financial support by National University of Singapore through the Ministry of Education Academic Research Fund, Grant No. R246000234133, by the US National Science Foundation grants HRD-0734825 (Cyber-ShARE Center of Excellence) and DUE-0926721, by the US Grant 1 T36 GM078000-01 from the National Institutes of Health, and by a grant on from the US Office of Naval Research.