A Comparison of Information Management using Imprecise Probabilities and Precise Bayesian Updating of Reliability Estimates

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Abstract

The assessment of the reliability of components and subsystems is an important problem in engineering design. Estimates of the reliability of a design can play a significant role in final design decisions. Data for making these estimates is often scarce during the design process. However, designers also frequently have the option to acquire more information by expending resources. Designers thus face the dual questions of how to update their estimates and whether it is valuable to collect additional information. Various statistical updating methods exist and can be used in reliability estimation, including precise Bayesian updating and methods based on imprecise probabilities. In this paper, the application of these two methods is demonstrated in the context of reliability estimates of general engineering components and subsystems. Emphasis is placed on exploring the types of inferences that can be drawn from the resulting updated reliability estimates, paying special attention to how these methods reflect the amount of information on which the estimates are based. The goal of the paper is to explore the practical implications of using precise or imprecise probabilities while avoiding the more philosophical issues often discussed in the literature. Building on existing work that focused on the updating question [1], the important, forward-looking question of additional information collection will be explored in more detail than previously developed. It will be shown that by using imprecise probabilities, engineers can gain more insight into both the existing information and the reduction of uncertainty that can result from the acquisition of additional information. These ideas combine elements from sensitivity analysis, value of information calculations, and uncertainty measures.

References

[1] Aughenbaugh, J. M., and Herrmann, J. W., 2007, "Updating Uncertainty Assessments: A Comparison of Statistical Approaches," *2007 ASME International Design Engineering Technical Conferences*, Las Vegas, NV, September 4-7, 2007, paper no. DETC2007-35158.