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Answer

Elicitation of expert opinions for uncertainty and risks
Answer to the Book Review by Roger M. Cooke

I thank Professor Cooke for his comments on the book. Professor Cooke is known for his probability inclination, and attacks on any works in representing uncertainty by other means. He managed to not appreciate and miss the main contributions and value of the book. This response is meant to provide readers with appropriate perspectives and a healthy debate.

The following paragraphs provide responses to comments by Professor Cooke and more details to readers of the review:

- The reviewer starts by presenting the chapter structure of the book. This summary should be helpful to readers of the review. For more information, I provide the following details.
  The seven chapters of the book lead the readers from the definition of needs, to foundations of the concepts covered in the book, to theory, and finally guidance and applications. The first chapter provides an introduction to the book that discusses knowledge, its sources and acquisition, and ignorance and its categories as bases for dealing with experts and their opinions. The practical use of concepts and tools presented in the book requires a framework and a frame of thinking that deals holistically with problems and issues as systems. Background information on system modeling is provided in Chapter 2. Chapter 3 provides background information on experts, opinions, expert-opinion elicitation methods, methods used in developing questionnaires in educational and psychological testing and social research, and methods and practices utilized in focus groups. Chapter 4 presents the fundamentals of classical set theory, fuzzy sets, and rough sets that can be used to express opinions. Basic operations for these sets are defined and demonstrated. Fuzzy relations and fuzzy arithmetic can be used to express and combine information collected. The fundamentals of probability theory, possibility theory, interval probabilities, and monotone measures are summarized as they relate to the expression of expert opinions. Examples are used in this chapter to demonstrate the various methods and concepts. Chapter 5 presents methods for assessing or scoring expert opinions, measuring uncertainty contents in individual opinions and aggregated or combined opinions, and selecting an optimal opinion. The methods presented in this chapter are based on developments in expert opinion elicitation, and uncertainty-based information in the field of information science. Chapter 6 provides guidance on using expert-opinion elicitation processes. These processes can be viewed as variations of the Delphi technique with scenario analysis based on uncertainty models, ignorance, knowledge, information and uncertainty modeling related to experts and opinions, and nuclear industry experiences and recommendations. Chapter 7 demonstrates the applications of expert-opinion elicitation by focusing on occurrence probabilities and consequences of events related to naval and civil works systems for the purposes of planners,

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engineers, and others should they choose to use expert judgment. In each chapter of the book, computational examples are given in the individual section of the chapter, with more detailed engineering applications given in a concluding chapter. Also, each chapter includes a set of exercise problems that cover the materials of the chapter. The problems were carefully designed to meet the needs of instructors in assigning homework and the readers in practicing the fundamental concepts.

- The book in its coverage of philosophy does not have any "selection" bias. Chapter 1 was intended to cover selected philosophers that are representative of various schools and/or time periods. I did not intend to provide complete coverage of this subject due to page limitations and so that not to depart from the main focus of the book. Covering the works of Keynes, Borel, Von Mises, Ramsey, Von Neumann and Morgenstern, Popper, De Finetti, and Savage, modern philosophy of science, and semantic analysis might necessitate removing other materials from the book that are more essential to its scope and focus.

  The reviewer overstates his concern on this introductory chapter.
- Chapter 4 was written to meet the needs of primarily engineers and scientists. Mathematicians might also benefit from the style and scope of coverage in how to communicate to engineers and scientists in relevant terms. Introducing any mathematical jargon that is not strictly relevant to the subject at hand will turn off potential readers. The readers are assumed to have some background in set theory, and therefore more attention is given to fuzzy sets and fuzzy arithmetic in the book since they might constitute new concepts to significant readership.
- The review does not indicate which type of readers will benefit most from reading the book. The book was written for practitioners. I designed this easy-to-read book for analysts, researchers, and/or anyone who deals with experts or utilizes expert opinions to solve problems and for decision making. It was not designed strictly for mathematicians, and consequently does not include the mathematical bases that Professor Cooke is looking for. The book was designed for use in the fields of information science, philosophy, psychology, economics, engineering, sciences, forecasting, probability, statistics, reliability, risk analysis, medicine, law, and social sciences.

  This diversity requires a style of writing that seems to not meet the expectation of the reviewer. For example, engineers could use the book for assessing failure probabilities and consequences, life expectancy, condition assessment, failure rates, accident rates, and technology forecasting. In astrophysics, the book can be used for assessing distances and sizes. Biologists can use it to assess behavior of colonies. Other uses could include inter-dependencies in botany; mineral and oil exploration in geology; land use and wildlife habitat in environmental engineering and sciences; consequence assessment, expected life, market share, forecasting, market dynamics, and competition assessment in economics; decision analysis, investment, and stock, commodity and market trends in finance and investment; group behavior, conflict management, and motivation and personality in psychology; uncertainty and knowledge in philosophy; conflict development and management. and democratic changes in political science; litigation issues such as strategies, tactics and amounts, legislative strategies and tactics, settlement, and appeals in law; and diagnoses, and treatment selection and definition in medicine. The readers will especially appreciate the real-world case studies that are used to illustrate the basic principles. The book was purposely designed to emphasize the applications of the concepts presented. The fundamental concepts are properly balanced in seven well-organized chapters.
- The reviewer does not present a reasoned evaluation of the book. It presents an attack using issues, such as fuzzy sets and membership values, that have been debated in other forums for many years

without resolutions to some people. Lack of resolution does not diminish the value of the book. Bringing these debates into this review does not have any added value to readers since the book does not address these debates and was not designed for this purpose.

- The review was not written in such a manner as to promote understanding and further discussion. The review is not balanced. For example, the central figure on ignorance classification that appears on the book cover was not mentioned at all in the review. This ignorance classification was not described to the readers, and was not discussed. Instead the reviewer resorted to mathematical operations and axioms that are not essential to the book, and presented concerns and issues that are debated elsewhere and not in the book.
- The review is not fair and accurate in its presentation of the evidence, arguments, and methodology of the book. The review provides useless mathematical developments and debates that are not central to the book. The "Gender of Quincy" example is misleading since it does not utilize all the information known to us in this case, such as the mutual exclusiveness of male and female designation to one person at the same time. The contradiction stems from this piece of information, which will lead to contradictory results, if not utilized, even in probability theory.

In summary, the book was designed for users of the methods and tools presented in it, not for theoreticians. Its design and development were driven based on meeting needs in the fields of information science, philosophy, psychology, economics, engineering, sciences, forecasting, probability, statistics, reliability, risk analysis, medicine, law, and social sciences; and offer opportunities to theoreticians and mathematicians to advance our state of knowledge in areas that are relevant to and critical for these societal needs.

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