Chapter 15
Fuzzy-DSS Human Health Risk Assessment Under Uncertain Environment

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ABSTRACT

It is always utmost essential to accumulate knowledge on the nature of each and every accessible data, information, and model parameters in risk assessment. It is noticed that more often model parameters, data, information are fouled with uncertainty due to lack of precision, deficiency in data, diminutive sample sizes. In such environments, fuzzy set theory or Dempster-Shafer theory (DST) can be explored to represent this type of uncertainty. Most frequently, both types of uncertainty representation theories coexist in human health risk assessment and need to merge within the same framework. For this purpose, this chapter presents two algorithms to combine Dempster-Shafer structure (DSS) with generalized/normal fuzzy focal elements, generalized/normal fuzzy numbers within the same framework. Computer codes are generated using Matlab M-files. Finally, human health risk assessment is carried out under this setting and it is observed that the results are obtained in the form of fuzzy numbers (normal/generalized) at different fractiles.

INTRODUCTION

Uncertainty plays an imperative role in decision making course of action. Therefore, it is really entailed to know the temperament of all available information, data or components of models in risk assessment. Usually, two kinds of uncertainties occurs viz., *aleatory uncertainty* arises due to inherent variability, natural stochasticity, environmental or structural variation across space or time, due to heterogeneity or the random character of natural processes and *epistemic uncertainty* transpires due to scarce or incomplete information or data, measurement error or data obtain from expert judgment or subjective interpretation of available data or information. Generally probability theory (PT) is considered as a well-recognized Mathematical tool to deal with *aleatory uncertainty* and therefore, available information/data are con-

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strued in terms of probabilistic sense. However, it is well known that not all available information, data or components of models are affected by *aleatory uncertainty* and can directly be handled by conventional PT. *Epistemic uncertainty* also more often occurs in real world situations/problems. Thus, if components of models, data/information are affected by such kind of (*epistemic*) uncertainty conventional PT is improper to represent *epistemic uncertainty*. To prevail over the limitation of PT, Zadeh (1965) set up a new theory called FST. Dempster (1967) put forward another theory which is known as DST. FST is more appropriate in such circumstances where *epistemic uncertainty* is generally involved. On the other hand, the use of DST in risk assessment has numerous advantages upon the usual PT approaches. DST is especially useful for modelling uncertainty when we don't have enough data and need to depend on specialist judgment. The elementary objects of DST are called focal elements and the primitive function associated with it is called basic probability assignment (BPA). A DSS can be depicted by focal elements and its corresponding BPA. Experts' judgments are needed when encountering uncertainty, ignorance and complexity are involved in the system. It is needed to deal with the circumstances where cost of technical difficulties involved or uniqueness of the situation under study make it difficult/impossible to make enough observations to quantify the models with real data. Sometimes, these are also used to refine the estimate obtained from real data as well. Generally in DST, specialists provide BPA for interval focal elements. However, in real world problem it can be easily observed that data/information are imprecise or incomplete due to insufficient knowledge (Dutta et al., 2011b) and therefore, due to the occurrence of uncertainty, data/information can be treated as generalized triangular/normal triangular fuzzy number (TFN) because TFN encodes only most likely value (mode) and the spread (confidence interval). Hence, a comprehensive form of DST can be obtained.

Problem Statements

Components of health risk assessment models are frequently fouled with *epistemic uncertainties*. In such circumstances, it may occur that depictions of some uncertain input components of models are of DSS with fuzzy focal elements while depictions of some other components of models are fuzzy numbers (FNs). To deal with such situation, one has to develop a new efficient coalesce technique. Thus, coexistence of DSS and FNs make the situation complex to perform health risk assessment. Situations become more and more complex when GFNs are involved in the system. Hybridization of FNs and DSS with fuzzy focal elements of different shapes, technique yet not encountered to carry out risk assessment.

Motivations

As components of the models representing real world problems, in general are tainted with *epistemic uncertainty,* and as a consequence, representations of some uncertain model parameters are of DSS with fuzzy focal elements and some others are TFNs. In such circumstances, it is important to develop a new efficient amalgamate technique. In literature no any such approaches have been seen to unite DSS and FNs. This motivates us to device an efficient technique to unite DSS with fuzzy focal elements of different shapes and FNs with different shapes and types within the same framework.