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Method article

Modeling of variability and uncertainty in human health risk assessment

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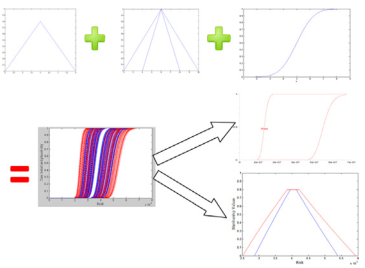
GRAPHICAL ABSTRACT



ABSTRACT

Health risk assessments have been carried out worldwide to examine potential health risk due to exposure to toxic contaminants in various environments. In risk assessment, it is most important to know the nature of all available information, data or model parameters. It is observed that available information/data are tainted with uncertainty and variability in the same time, i.e., uncertainty and variability co-exist. In such situation it is important to devise method for processing both uncertainty and variability into same framework and which is an open issue. In this regards, this paper presents an algorithm to combined approach to propagate variability and uncertainty in the same framework. The differences and advantages of this algorithm over the existing methods are presented below:

- The representation of uncertain model parameters are probabilistic together with generalized fuzzy numbers and normal interval valued fuzzy numbers.
- The results obtained are then interpreted in terms of p-box and fuzzy numbers.
- The advantage of this approach over the existing methods is that this approach gives an accurate resultant fuzzy number which is of trapezoidal type generalized fuzzy number that is different from the existing methods.

ARTICLE INFO

Keywords: Variability and uncertainty, Generalized fuzzy numbers, Interval valued fuzzy numbers, Risk assessment

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Uncertainty modeling approaches

Uncertainty is an integral and unavoidable part of risk assessment. Based on the nature and availability of data variability and uncertainty can be modeled using probability theory and fuzzy set theory.

Probability theory

Probability theory frequently used in variability analysis. If parameters used in prescribed models are random in nature and followed well define distribution, then probabilistic methods are most suitable and well accepted approach for risk assessment.

This approach can describe variability arising from stochastic disturbances, variability conditions, and risk considerations. Variability is characterized by the probability associated with events. The probability of an event can be interpreted in terms of frequency of occurrence which can be defined as the ratio of the number of favorable events to the total number of events. In this approach, the uncertainties associated with model inputs are described by probability distributions, and the objective is to estimate the output probability distributions.

A random variable is a variable in a study in which subjects are randomly selected. Let X be a discrete random variable.

A probability mass function is a function such that

$$\text{(i) } f(x_i) \geq 0, \text{ (ii) } \sum_{i=1}^{n} f(x_i) = 1 \text{ (iii) } f(x_i) = p(x = x_i)$$

The cumulative distribution function of a discrete random variable X, denoted as F(x) is

$$F(x) = P(X \leq x) = \sum_{X \leq X_i} f(x_i)$$

Let X be a continuous random variable. A probability density function of X is a non-negative function f, which satisfies

$$P(X \in B) = \int_B f(x)dx$$

for every subset B of the real line.

As X must assume some value, f must satisfy

$$P(X \in (-\infty, \infty) = \int_{-\infty}^{\infty} f(x)dx = 1$$

This means the entire area under the graph of the PDF must be equal to unit.

In particular, the probability that the value of X falls within an interval [a, b] is

$$p(a \leq X \leq b) = \int_a^b f(x)dx$$

The CDF of a continuous random variable X is

$$F(x) = P(X \leq x) = \int_{-\infty}^{x} f(x)dx$$