

## FUZZY RANDOM VECTORS WITH STEPWISE MEMBERSHIP LEVELS AND THEIR APPLICATION TO QUESTIONNAIRE SURVEY

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**ABSTRACT.** *In this paper, the authors investigate a class of fuzzy random vectors, where they are considered as vague perceptions of random phenomena. First, based on the results previously proposed by the author, fuzzy random vectors are defined from the viewpoint of the multivalued logic, where for convenience of the numerical feasibility, the set representation of fuzzy sets is approximated by the stepwise membership levels. Secondly, the expectation and the variance of fuzzy random vectors obtained by the multivalued logic are considered, and the variance by Fréchet approach is introduced. The estimates of the expectation and two types of variances are also considered. Finally, the proposed fuzzy random vectors are applied to the analysis of statistical properties of the data obtained from the questionnaire concerned with bowling ball design.*

**Keywords:** Fuzzy random vectors with stepwise membership levels, Fuzzy random data, Variance by multivalued logic, Variance by Fréchet approach, Questionnaire survey

**1. Introduction.** In recent years, motivated by the importance for treating the data exhibiting both vagueness and randomness, fuzzy random variables or more generally fuzzy random vectors have been intensively investigated by many researchers with various definitions. For instance, the concept of fuzzy random variables obtained as vague linguistic observations of crisp random data was firstly presented by Kwakernaak [1,2], and investigated by e.g., Boswell [3], and Kruse [4-9]. Using Zadeh's probability measure of fuzzy events [10], Konishi and et. al. [11], proposed the variance of fuzzy interval data. On the other hand, Puri and Ralescu [12] defined firstly fuzzy random variables as the generalized random sets and discussed their statistical properties [13,14]. From this viewpoint of fuzzy random variables as the generalized random sets, many researchers have been investigated intensively. Such phases are observed in Negoita and Ralescu [15], Inoue [16], Li and Ogura [17,18]. Recently, Krätschmer [19-21] presented the precise discussion of the measurability of fuzzy random variables.

Consider, for instance, the situation of evaluating the result of questionnaire surveys for getting the basic knowledge concerned with the taste of customers. Needless to say the taste of customers should be vague, and hence the answers of those questionnaire cannot help using the vague words like "very good", "good", "bad" and so on. Furthermore, it should be also taken into consideration that those answers fluctuate randomly due to the personalities of persons. This means that we get only the data from the questionnaire which have both properties of the vagueness and the randomness.

One of the authors of this paper has continuously and consistently investigated the fuzzy random vectors (see e.g. [22-25] and their references), which are considered as vague

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