Nikolaos I. Ioakimidis, 2022, Problems under uncertainty: quantifier elimination to universally–existentially (AE) quantified formulae related to two or more horizons of uncertainty, March 2022, DOI: 10.13140/RG.2.2.22282.34247

Abstract Problems under uncertainty appear frequently in practical applications. Ben-Haim's IGDT (info-gap decision theory) constitutes a very efficient method for the study of such problems. The three components (or elements) of Ben-Haim's IGDT are (i) the system model, (ii) the info-gap uncertainty model and (iii) the performance requirement(s). Appropriate (mainly positivity) assumptions can also be made. Here we use the IGDT only partially by restricting our attention to its first component, the system model, and to its second component, the info-gap uncertainty model, but paying no attention to the performance requirement(s) also very important in the IGDT. Here an emphasis is put on the use of (mixed) universally–existentially (AE) quantified formulae assuring the validity of the system model (under the assumptions made) for all values of the universally quantified uncertain variable(s) and for at least one value (or a set of values) of the existentially quantified uncertain variable(s) of course provided that these quantified variables satisfy the adopted info-gap uncertainty model here the popular fractional-error model. On the other hand, here we also assume that each uncertain variable (either universally or existentially quantified) has its own uncertainty parameter (or horizon of uncertainty). Next, by using the method of quantifier elimination in its powerful implementation in the computer algebra system Mathematica we transform the quantified formula to an equivalent QFF (quantifier-free formula) free from the quantifiers and the quantified variables, but, evidently, including the horizons of uncertainty. Two simple applications concerning (i) a product/quotient and (ii) the buckling load of a fixed–free column illustrate the present approach with the derivation of the related QFFs, some of which can also be verified manually.

Keywords Uncertainty, Uncertainty parameter, Horizon of uncertainty, Information-gap, Info-gap, IGDT, System model, Info-gap uncertainty model, Universal quantifier, Existential quantifier, Universally–existentially (AE) quantified formulae, Quantifier elimination, Quantifier-free formulae, Product, Quotient, Fixed–free column, Buckling load

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