

Nikolaos I. Ioakimidis, 2021, Quantifier elimination and quantifier-free formulae for universally–existentially (AE) quantified formulae in Ben-Haim’s info-gap model of uncertainty, Technical Report No. TR-2021-Q18, December, 2021, deposited to Nemertes and appeared online also at Nemertes. DOI: 10.13140/RG.2.2.32057.70246

Abstract The method of quantifier elimination with implementations in some computer algebrasystems already proved useful for the computation of both the robustness and the opportuneness(or opportunity) functions in Ben-Haim’s info-gap (or information-gap) model of uncertainty. Asis well known, this model constitutes an interesting and practical tool in decision theory. More-over, quantifier elimination concerning the robustness/opportuneness functions can be performedto the related universally/existentially quantified formulae. Here we proceed to the consideration ofthe additional mixed (AE) case, where both the universal and the existential quantifiers are presentin the quantified formula related to Ben-Haim’s info-gap model of uncertainty. In this mixed (AE)case, evidently now with more than one uncertain variable, the universal quantifier concerns one (ormore than one) uncertain variable and similar is the case with the existential quantifier. After per-forming quantifier elimination to this quantified formula (here by using the computer algebra sys-temMathematica), we derive the related QFF (quantifier-free formula) that concerns the horizon ofuncertainty. The case of more than one horizon of uncertainty can also be similarly studied. In thisway, an expression for the horizon of uncertainty in a logical form with the appropriate inequalitiesis derived. From this form it is observed that additional immunity functions (beyond the classicalrobustness and opportuneness functions) appear in the mixed universal–existential (AE) case. Thepresent approach is applied to four uncertainty problems which are based on info-gap models andconcern (i) the area of a rectangle, (ii) the buckling load of a fixed–free column, (iii) the volume ofa rectangular cuboid and (iv) the reactions at the ends of a fixed beam loaded by a concentrated load.

Keywords Uncertainty; Info-gap; Information-gap; IGDT; Non-probabilistic methods; Robust reliability; Robustness; Opportuneness; Universal quantifier; Existential quantifier; Quantified formulae; Quantifier elimination; Quantifier-free formulae; Rectangles; Area; Rectangular cuboids; Volume; Columns; Buckling load; Beams; Reactions; Mathematica