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B. De Baets, H. De Meyer

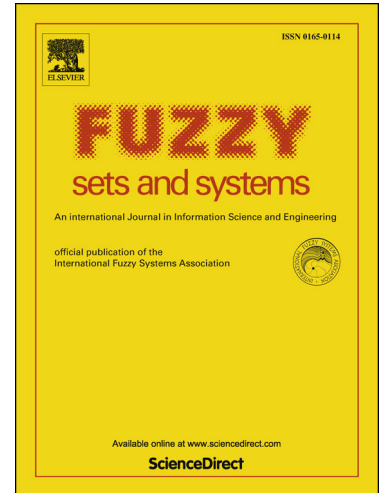
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The Frank inequality

B. De Baets^a and H. De Meyer^b

^a*Department of Mathematical Modelling, Statistics and Bioinformatics,
Ghent University, Coupure links 653, B-9000 Gent, Belgium*
bernard.debaets@ugent.be

^b*Department of Applied Mathematics, Computer Science and Statistics,
Ghent University, Krijgslaan 281 S9, B-9000 Gent, Belgium*
hans.demeyer@ugent.be

Abstract

We investigate a functional inequality for copulas that has emerged from our study of the comparison of a set of random variables pairwise coupled by a same copula. Any copula satisfying this inequality is necessarily symmetric and radially symmetric. Moreover, any associative copula satisfying this inequality is a solution to the well-known Frank equation. For this reason, the inequality is coined the Frank inequality. We fully characterize the associative copulas that satisfy the Frank inequality: they turn out to be either Frank copulas or ordinal sums of a same Frank copula with equidistant idempotent elements. As a by-product, we observe that Frank copulas are super-additive on the unit square.

Key words: Associative copula, Frank copula, Frank equation, Frank inequality, Super-additivity, Radial symmetry.

1 Introduction

Triangular norms (t-norms for short), originating from the theory of probabilistic metric spaces, have been playing a key role in fuzzy set theory for decades. They have quickly become the unquestioned standard for modelling the pointwise intersection of fuzzy sets as well as for the modelling the conjunction in fuzzy logic [27]. The search for t-norms satisfying additional interesting properties has led to a number of interesting functional equations (see, e.g., [2,3,7,9]), resulting in well-known parametric families of triangular norms and conorms [30].

Also the theory of probabilistic metric spaces has been a source of interesting functional equations. In the past, many investigations were aimed at finding

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