

i.e., I^\rightarrow fulfils (CP) with respect to N_s . In this case we can define two generator triples:

$$\begin{aligned} p_1(x, y) &= C(x, 1 - y), \\ i_1(x, y) &= C^{\text{flip}^2}(x, y), \\ j_1(x, y) &= C_{\text{flip}1}(1 - x, 1 - y) \\ &= C^{\text{flip}^2}(1 - x, 1 - y), \end{aligned}$$

and

$$\begin{aligned} p_2(x, y) &= C^{\text{flip}^2}(x, 1 - y), \\ i_2(x, y) &= C(x, y), \\ j_2(x, y) &= C(1 - x, 1 - y). \end{aligned}$$

3. Conclusions

In this paper we have found a necessary and sufficient condition under which continuous generator triples can be constructed via quasi-copulas. In the case that C is a quasi-copula whose flips are commutative, we have shown that this condition is equivalent to the condition that the corresponding probabilistic implication I^\rightarrow is continuous, bounded by I_{S_M} from below and by I_{S_L} from above, and moreover I^\rightarrow fulfils (CP) with respect to N_s .

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References

- [1] M. Baczyński, B. Jayaram, *Fuzzy implications*, volume 231 *Studies in Fuzziness and Soft Computing*, Springer, Berlin, 2008.
- [2] B. Bassan, F. Spizzichino, Dependence and multivariate aging: the role of level sets of the survival function. In *System and Bayesian Reliability*, Series of Quality Reliability Engineering Statistics, Vol.5, pages 229-242, World Scientific Publishers, River Edge, NJ, 2001.
- [3] F. Durante, E.P. Klement, R. Mesiar, C. Sempi, Conjunctors and their residual implicators: characterizations and construction methods, *Mediterranean J.Math.* 4:343-356, 2007.
- [4] J. Fodor, M. Roubens, *Fuzzy preference modelling and multicriteria decision support*, Kluwer Academic Publishers, Dordrecht, 1994.
- [5] P. Grzegorzewski, Probabilistic implications, *Fuzzy sets and Systems*, Elsevier, 2013, <http://dx.doi.org/10.1016/j.fss.2013.01.003>
- [6] P. Hájek, *Mathematics of Fuzzy Logic*, Kluwer Academic Publishers, Dordrecht, 1998.

- [7] J. Kalická, On some construction methods for 1-Lipschitz aggregation functions, *Fuzzy sets and Systems*, 160:726-732, Elsevier, 2009.
- [8] E.P. Klement, R. Mesiar, E. Pap. *Triangular Norms*, Trends in Logic. Studia Logica Library, Vol.8, Kluwer Academic Publishers, Dordrecht, 2000.
- [9] R.B. Nelsen, *An Introduction to Copulas*, second ed., Springer Series in Statistics, Springer, New York, 2006.
- [10] V. Novák, I. Perfilieva, J. Močkoř, *Mathematical Principles of Fuzzy Logic*, Kluwer Academic Publishers, Boston, 1999.
- [11] A. Sklar, Fonctions derépartition à n dimensions et leurs marges, *Publ. Inst. Statist. Univ. Paris* 8: 229-231 1959.
- [12] B. Van De Walle, B. De Baets, E. Kerre, A comparative study of completeness conditions in fuzzy preference structures. In proceedings of IFSA'97, vol. III, Academia, Prague, 1997, pages 74-79.
- [13] L.A. Zadeh, Similarity relations and fuzzy orderings, *Information Sciences*, 3:177-200, Elsevier, 1971.