QUANTUM-LOGIC/PROBABILITY ASPECTS OF CONNECTIVES IN FUZZY LOGIC

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Background

The future of fuzzy set theory greatly depends on the development of systematic ways of generalizing classical results to a graded setting. Far too often, such a generalization is done on a case by case basis, reinventing the wheel over and over again. However, instead of looking for multiple theorems, one should rather aim for a single powerful meta-theorem.

In former work at KERMIT, an interesting example of such a meta-theorem has been uncovered. The generalization of classical similarity measures, abundant in practically all branches of science where set-based comparison is at stake, to a graded setting, essentially depends on a model for graded conjunction, often realized by means of a conjunctor, in particular a quasi-copula or t-norm. It turns out that the transitivity of such similarity measures is preserved when the conjunctor used satisfies a number of inequalities that show a striking resemblance with some Bell-inequalities from probability theory. A first such inequality was discovered by Pykacz and D'Hooghe. On the other hand, some connectives in fuzzy logic have been inspired by quantum logic operations.

It is clear that a more profound study would be welcome, revealing deeper connections between Bell-inequalities and fuzzy connectives, in particular those related to quantum logic in one sense or another. Furthermore, their role in the study of inequality-based properties of fuzzy relations should be further unveiled.

Related reading

B. De Baets, S. Janssens and H. De Meyer, *Meta-theorems on inequalities for scalar fuzzy set cardinalities*, Fuzzy Sets and Systems **157** (2006), 1463–1476.

S. Janssens, B. De Baets and H. De Meyer, *Bell-type inequalities for quasi-copulas*, Fuzzy Sets and Systems **148** (2004), 263–278.

I. Pitowsky, Quantum Probability – Quantum Logic. Lecture Notes in Physics, Vol. 321, Springer, 1989.

J. Pykacz and B. D'Hooghe, *Bell-type inequalities in fuzzy probability calculus*, Internat. J. of Uncertainty, Fuzziness and Knowledge-Based Systems **9** (2001), 263–275.