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Commentary on Woods

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In Response To: John Woods's *Is there a place for fuzzy logic in practical reasoning.*

When Montgolfier raised his first hot-air balloon in 1783 he was asked what possible use it was. His answer was "What is the use of a child?" Fuzzy logic is no longer a child, and it is therefore a bit misleading, now that we have 40,000 fuzzy logic web sites, several journals, fan clubs around the world, and many successful applications, to base a critique of it on papers that are twenty years old, as Susan Haack does in her 1996 edition of *Deviant Logic*. She is quoting a ten year old child that has now grown to be thirty.

There is a certain quarrelsomeness in the discussion of the subject. It has been called the "cocaine of science"[1] and "pornography"[2]. This should not surprise; abuse is common in logic. Locke called logicians "cattle ... whose thoughts reach only to imitation" (*Essay*4.17.3/6/7),[3] and Alexander Pope, accordingly, speaks of "A hundred Head of Aristotle's Friends..." (*Dunciad* iv, 191 ff.). Diderot called logicians "dirty, fetid pedants."[4] These were summary judgments of outsiders, but insult or at least derision is common as well within the fraternity, in disputes between "traditional" logicians and "classical" logicians, between the latter and advocates of relevance, Quine and modal logicians, formalists and informalists, and so on. Now that fuzzy logicians invite traditionalists and classicists to come out and play, they get sour looks.

It is instructive to look at earlier reactions to innovative logic systems, for instance Quine on modal logic. If you believed him, or perhaps better, if you believed *in* him, as some of people I respect actually did, you did not pay much attention to modal systems when the field exploded after 1961. This same lot can now talk about modal logic as a fad that has passed. Many years ago, when I came home much excited from a performance of Orff's *Carmina Burana* my roommate challenged me to name *one thing* in that piece that Stravinsky had not done before. Of course I could not. But as with modal logic, it was fun. So even if, perhaps, the modal logic has no application to *practical* logic, it is fun while one is at it, rather like music, in fact. Quine was not able to warn me off modal logic any more than my mother was able to warn me off girls. Is it perhaps the same with fuzzy logic? There is the gaming aspect to it, the sheer fun of exploring its premisses, and the stunning successes, to which Woods repeatedly calls attention, of its engineering applications. But perhaps engineering is all there is to it, and the field of informal logic is a separate thing that is neither helped nor hindered by the fuzzy stuff.

Fuzzy sets were described by Zadeh in 1965[5] to deal with vagueness. According to Brulé, Plato laid the foundation to what would become fuzzy logic when he said that there was a third region (beyond True and False) where these opposites "tumble about."[6] My own understanding of fuzzy sets does not go much beyond Plato's. For this reason, and for lack of time I won't attempt to insert even a brief tutorial at this point.[7] Zadeh also sought to make truth into a fuzzy notion, introducing such expressions as "very true", and the like. Much of the criticism of his work centers on this attempt, which Haack and others take to be misguided. I shall not pursue this, and will instead say a few words about the bigger fish that Woods deals with, starting at the end.

He, as Haack did before, make much of the fact that there is an underlying logic, or logical framework to fuzzy logic that is “entirely classical.” Woods says, “It is rather striking that all these engineering applications are generated within a logico-mathematical framework that is entirely classical” (17). This goes a long way toward explaining, he maintains, why this stuff works.

I don’t quite know what to make of this argument. Anything a computer does is classical at least in the sense that at the machine level only two values are available, on or off. Everything else must be achieved with networks of on and off switches. Suppose you listen to a compact disk of Mozart’s Clarinet Quintet (as I was doing when writing this). Why does it work, i.e. , sound so good? Not, John Woods seems to tell us, because the music is by Mozart, and James Campbell is a mean clarinet player, but because the recording is produced and reproduced within a logico-mathematical framework that is entirely classical. But apparently, computers can deal with sound, with crescendo and glissando, etc. on the basis of a “classical” computer architecture. From the nature of the computer architecture we cannot conclude that what we listened to was in a deep sense not music. And so also, even if the “underlying” logic, the “logical framework” is classical, it can still deal with real vagueness, and not only with some surrogate of it.

Moving back from the end of John’s paper, we find a reference to Heidegger and coping. I agree with a bit of what Heidegger is saying: consciousness is a rather perfunctory public relations effort of the mind, and a lot of problem solving and reasoning, though perhaps not arguing, takes place on a pre-conscious or sub-conscious level. I do not think, however, that linguistic coping, as contrasted with conscious conversation, is as common as Woods thinks. One does tend to come to this conviction, however, after many years in academic administration.

Now to his example of coping: the short order cook in New York. Let me describe another case that is actually cited in the fuzzy literature. I quote Brulé:

> The first major commercial application was in the area of cement kiln control, an operation which requires that an operator monitor four internal states of the kiln, control four sets of operations, and dynamically manage 40 or 50 "rules of thumb" about their interrelationships, all with the goal of controlling a highly complex set of chemical interactions. One such rule is “If the oxygen percentage is rather high and the free-lime and kiln-drive torque rate is normal, decrease the flow of gas and slightly reduce the fuel rate.”[8]

I have worked at a blast furnace and at a cement kiln, so I know whereof we talk here. It is true enough that the controller does these things rather automatically, perhaps even sometimes without consciousness. But that does not mean that the entire area of cement kiln control falls into the domain of the subcortical, prelinguistic, unconscious. The teaching of these techniques typically involves the expression *in language* of the rules of thumb, and their *conscious* absorption. The fact that someone can control a lime-kiln by just coping does not mean that he learned to cope on a level appropriately described as subcortical, subconscious, prelinguistic and non-linear (p. 10). Expressions formulated in the fuzzy vocabulary may yet be the best way of formalizing the language used in lime-kiln operation instruction. In a way, then, I agree with Woods when he says that "there exists abundant evidence that a good deal of reasoning in subconscious. To the extent that this is so, fuzzy logic may well be a model of the right type" (16). But I don't know if he wants to draw a rigid line here or not. He seems to suggest that practical reasoning is sometimes conscious and sometimes not (16) and that fuzzy logic is not a model for it if it is conscious, since consciousness "cannot abide high levels of information." But there is a step missing in the argument. It may be true that fuzzy logic can handle very large amounts of information, but for this argument to go through, it must be shown that it *cannot* handle small amounts. The quotation from Zadeh on p. 16 does not seem to me to support Woods's point. He says, rather, that precise statements about very complex systems are unmanageable, but fuzzy ones are not.

I mention another problem in passing. Earlier in the paper John makes reference to Quine's contrast between the meager traces of input upon the senses, and the torrential output of theories, claims, etc. (p. 8). Later we hear about torrential input and processing, and meager output. I can't quite get these two things together, but that may just be a misunderstanding. I am similarly puzzled by the claim that fuzzy logic is unmanageably complex (p.7), more so, evidently, than the classical version, but that it is able to deal with vastly more data at one time.

I now come to the claim that classical logic does not fail in English. This is interpreted (p. 11 f.) as meaning that there are no argument forms in the classical predicate calculus that fail in English. "Classical" is not altogether clear, but I take it to mean a bivalent system of logic, with a non-empty domain, quantifiers and extensionally defined connectives. Now the passage quoted from Zadeh (p. 11) does not suggest that this is what he had in mind. His claim seems to be, rather, that there cases of "human reckoning" that are not well captured in a "rigorous mathematical foundation." And this, surely, is true. Classical logic is a blunt instrument that fails to catch many interesting types of argument, enthymemes among them, but also cases in which vagueness plays a role.

Let me conclude with the following observation. A logic system does not only allow one to devise, evaluate and make precise arguments. Some of them can be, and have been, used to model human belief, decision and action. Some years ago, and even now in some quarters, it was held that a person's confidence in a proposition (e.g. that the plane he is about to board will in fact arrive) is to be described by a precise fraction m/n with 0 = m/n = 1. This fraction was thought to be determinable by bets and similar devices. But this, surely, is just silly. What we are dealing with here is a vague probability, a field best explored by using fuzzy probability logic. Fuzzy logic has certainly had the salutary effect of putting an end to the specious search for precision where none exists.

Endnotes

1 William Kahan, quoted in B. Kosko, *Fuzzy Thinking: The New Science of Fuzzy Logic;* New York: Hyperion 1963, p. 6, quoted from Woods, p. 7.

2 Susan Haack recalls Dana Scott saying this, *Deviant Logic, Fuzzy Logic;* Chicago, University of Chicago Press 1996, p. 130. Also cited in Woods, p. 7.

3 Locke was not consistent in his opinions about the function and utility of syllogisms. In the *Second Vindication of the Reasonableness of Christianity* of 1697, he calls it “the true touch stone of right arguing.” For more on this cf. Fraser's note in Locke (1959), Vol. II, 397 f. Charles W. Hendel discusses the influence of Arnauld on Locke and Hume in the Introduction to the *Art of Thinking,* Arnauld (1964), xviii - xxii.

4 Encyclopedie, “Syllogisme.”

5 Lotfi Zadeh: “Fuzzy Sets,” *Information Control*, Vol. 8, 1965, pp. 338-353.

6 James F. Brulé, “Fuzzy Systems – A Tutorial,” 1985, p. 2 http://www.austinlinks.com/Fuzzy/tutorial.html.

7 A claim like “Jack is tall” cannot be translated into a precise language without loosing some of its semantic value. Neither “Jack is 185 cm tall” nor “Jack is 1.2 standard deviations above the mean” and the like will do. In the fuzzy world, Jack will be said to be tall to a degree: mTALL(Jack) = 0.75, where the set of really and truly tall people catches all those of 190 cm and above, and the set of truly not tall people ends at 170 cm. Those in between are tall to a degree. So if X is a set of objects, with elements x, then a fuzzy set A in X is characterized by a membership function mA(x) which maps each element of X onto the real interval [0.0,1.0], with higher numbers indicating higher grades of membership.

We can now define complement, containment, union and intersection. One of the results will be that if we have mSMART(Jack) = 0.75, then Jack will be tall AND smart to degree 0.75. The contrast to probabilities is obvious, because if the probability of Jack’s being smart and being tall were each 0.75, and height and brains are independent, then the probability of Jack’s being both is the product, i.e.0.5625.

As a first quick and dirty approach, hedges, like “very”, “somewhat”, “more or less” are given that produce membership values according to a standard mathematical function. For example, “very” typically is assigned the square of the underlying value, hence   mVery Tall (Jack) = mTall (Jack)^2, or Jack's membership in the very tall set is 0.5625.

8Brulé p. 6. According to Brulé, a complete accounting of this very successful system can be found in Umbers and King, "An analysis of human decision making in cement kiln control and the implications for automation," Int. Jrnl. of Man-Mach. Stud., Vol 12, 1980, pp. 11-23.