Archives for the Philosophy and History of Soft Computing

Issue 1/2017

INTERNATIONAL ONLINE JOURNAL OPEN ACCESS

ISSN 2341-0183

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On how Fuzzy Logic began in Spain (1974-1980)

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1 Introduction

With this paper I will try to cover but a part of what happened from 1974 up to around 1980. After this year everything acquired such a dynamics and density that I don't feel myself able to seriously write on it. For instance, at the end of XX Century the scientific production on Fuzzy Logic and related areas did grow in Spain in such a way that the figures on it shown this country in a fourth or fifth position in the world, when before 1974 such production was inexistent even if some people did have some news on fuzzy sets. Indeed, the first conference's papers appeared in 1977, and this was the year in which an explosion of fuzzy logic started in Spain; after 1980 many groups along the Spanish geography were active, with many Ph. D Dissertations presented or in course, and conferences and international journal papers published. In six years after the end of Franco's totalitarian regime, between 1975 and 1981, in general and with a very poor funding, scientific research in Spain did abruptly change towards an intellectual and socially challenging activity. This, besides considering that regular funding coming from the European Union, did not arrive to Spain before 1988, and after having joined the EU in 1986.

In the years covered by this paper, what in Spain was accomplished in fuzzy logic should be considered as coming from the personal effort made by the involved researchers, and just counting with minor amounts of funding from public institutions. For instance, my own work in the field of Probabilistic and Generalized Metric Spaces, from which many Ph. D. Dissertations and publications did arise began before 1966, but it was supported only between 1972 and 1977 by a private Spanish Foundation

2 The preliminary steps

2.1

Alfredo Deaño (1944-1978) was an Adjoint Professor of Philosophy at the University of Madrid (UCM, Universidad Complutense de Madrid), unfortunately passed away when he was just 33 years old, and because of a sudden heard attack. It happened very close to when he could have obtained a Chair of Philosophy.

Deaño was a young promise for Spanish Philosophy; granted with a serious classical philosophical background, he kept a great interest on modern linguistic philosophy, deeply knew the syntactical work of Chomsky, the then existing publications on Vagueness, and both the 1965 Zadeh's paper introducing fuzzy sets, and the 1975 Lackoff's (first and last 'fuzzy' paper) on linguistic hedges[2]. Deaño's passing away meant a deep

lost for the future of, at least, analytic philosophy in Spain. I never met him what, surely, was a pity for me and, perhaps probably, also in relation with a shared vision on representing natural language and commonsense reasoning that could have been influencing in the future.

In a time in which Spain boiled of democratic aspirations hold by young university professors, who devoted a lot of their time to activities trying to present modern tendencies in several aspects of culture, Deaño intensively participated with the direction of a very interesting collection of books, translated into Spanish some books, and did have nice public presentations concerning philosophy, and fuzzy sets in particular.

After his death, unfortunately and as far as I know, no Ph. D. Dissertation on fuzziness was presented in the area of philosophy up to the end of the eighties in last Century, when Alejandro Sobrino read under my advise his dissertation at the University of Santiago de Compostela. Curiously, Deaño and Sobrino are both born in Galicia.

In his 1974 book 'An Introduction to Formal Logic' (Introducción a la lógica formal)[3], Deaño not only devoted some pages to fuzzy sets and to linguistic hedges, but also nice and interesting comments concerning fuzzy logic in connection with natural language. Most philosophers did learn concepts of fuzzy logic, along the years in which this book was used as a textbook in the classes of logic for future philosophers.

2.2

Francisco Azorín, was a known and mature mathematical statistician whose main interest concerned the sampling problems in statistics, and that, being a full-professor at the UAM (Universidad Autónoma de Madrid) and a UNESCO international consultant, after 1977 held for some years the Honorary Presidency of the National Institute of Statistics (INE, Instituto Nacional de Estadística), after he had been developing intense works in South-America as a member of CEPAL, as well as being a professor at some universities in Venezuela and Chile. Son of a known architect that was a prominent socialist before the Spanish Civil War, he was a man of a great culture, and a member of the Spanish Royal Academy of Sciences since 1981. Worried by the too much precise questions posed to people in the official surveys and opinion polls, and by the precise answers required, after knowing the work of Zadeh, Azorin tried to convince the INE's statisticians for the need to pose imprecise questions, to accept imprecise answers and represent them by fuzzy sets. Just for this the INE published in 1979 his booklet 'Some Applications of Fuzzy Sets to Statistics' (in Spanish)[4], but and perhaps is in his discourse of entrance at the Royal Academy, 'Fuzzy Sets, Statistics, and Probability' (also in Spanish)[5], where he did show a

wide knowledge on fuzzy logic. Unfortunately, Azorín also passed away in the mid eighties by an unpredictable complication after a minor surgical operation.

Although concerning fuzzy logic the direct influence of Azorin was limited among professional statisticians, a little bit later it moved some academicians to consider imprecise events and fuzzy methodology. Among them, and impelled by his former advisor Sixto Ríos at UCM, Pedro Gil (Valladolid, 1947), a full-professor at the University of Oviedo, began to take into account fuzzy events at the mid eighties, and created a productive research group at that University. In it and very soon, it should be remarked his sister María Ángeles Gil (Valladolid, 1953), now also full-professor at the same University, and who did a stay of a couple of years in Berkeley with Zadeh. Anyway, all this goes further than 1980.

2.3

These two steps ahead done by Deaño and Azorín alone, should be considered partially unsuccessful but only concerning the true and further development of fuzzy logic in Spain, even if they greatly contributed to a good reception of fuzzy logic in this country. That the trials of Deaño and Azorín were unsuccessful for introducing fuzzy logic, does only refer to not having supervised young students on fuzzy logic in both the respective fields of Philosophy and Statistics. From this fact, their efforts did remain almost bounded to their own works that today, and without continuity, just bright as a personal, even if an excellent, endeavor that should be remembered as, at least, a sign of a time in which Spain was trying, basically by its most cultivated intellectuals, to abandon the cultural isolation in which the crazy and absurd totalitarian regime suffered between 1939 and 1975, did enclose the country. A regime that, not only for not preserving human rights, but also for the old religious and intellectual surveillance it pretended, cannot deserve any kind of a historical pardon under whatsoever point of view it could be seen.

3 A small jump

3.1.

In the summer of 1975, and one year after becoming a full-professor of mathematics at the Technical University of Catalonia (UPC, Universitat Politècnica de Catalunya), I read in a French newspaper an interview with Professor Arnold Kaufmann, in which his new book ‘Ensembles flous’was announced. It called my attention since, having been working on Probabilistic Metric Spaces for several years after 1966, I knew Karl Menger’s wide work and, in particular, his paper on hazy sets that he

Christianized by 'ensembles flous', since he published it in French and in the famous 'Comptes Rendues' of the Paris Academy of Sciences[7]. Nevertheless, Kaufmann's book did not call too much my attention, since it seemed to me that its contents was fuzzy in itself; anyway, and mainly because of hazy sets, it lasted on me some curiosity moving me to search for the 1965 paper in which Lotfi A. Zadeh introduced 'fuzzy sets'. Its reading abruptly changed my mind since I recognized in fuzzy sets not only a way of giving 'extension' to imprecise predicates, but also that they allow to mathematically represent the imprecise statements of natural language, and that in principle they were not related with probability as Menger's hazy sets directly were.

It was for me a kind of a revelation that fuzzy sets appeared as a step ahead in the path going from Leibniz to Boole; for the first time, imprecise predicates P in a universe of discourse X, Q in a universe Y, etc., were represented by the membership functions of the fuzzy sets with linguistic labels P, Q, etc., and a composite statement linking elementary statements 'x is P', 'y is Q', etc., by connectives like 'and', 'or', and 'not', were also represented. This was clearly opening a window towards the representation of larger parts of natural language than classical sets, or Boolean algebras, allow to, and although no immediate axiom of specification does exist. It seemed to me that the famous 'Calculemus!' of Leibniz was approaching, and Zadeh's ideas captured my attention for ever. Fuzzy sets appeared to me as context-dependent and purpose-driven; not only as a matter of degree as Zadek likes to say, but as a matter of careful design; it was a new concept that produced me a passionate interest that, from then, I always saw closer to that of Deaño than to Azorín's one. I decided to work in the new field and started to search for the corresponding literature.

3.2.

Anyway, a few words concerning another reason for my sudden interest should be said. As a mathematician, I always kept a bad feeling towards simple generalizations, and hence my interest in fuzzy sets was not produced by the fact that they can be seen as a generalization of sets, that inside the set of all fuzzy sets in a universe X there is a subset isomorphic with the power set of X. On the contrary, and without denying such fact, what I did consider is that if in natural language there are more imprecise than precise words then, and at least from the point of view of mathematically representing language, it is more natural to look at sets as a kind of 'degenerate' fuzzy sets; this even if set theory, that is, mathematics, is necessary for building up such representation. A representation under which only classical sets do accept to be uniquely specified by an axiom like

that of Cantor-Zermelo and called of specification. That neither the membership function, nor the functions expressing the first connectives 'and', 'or', and 'not', are unique, make an important difference between Zadeh's fuzzy sets and classical sets. I did see fuzzy sets as the linguistic collective a predicate generates in the language, and not as a purely mathematical construct[8].

In this sense, I see mathematical models in fuzzy logic as something necessary, but not at all sufficient, for approaching the subtleties of natural language. From the beginning, I saw fuzzy logic as it appears in their last incarnation as Computing with Words[9], introduced by Zadeh a lot of years later at the end of XX Century. May be it is just an anecdote, but the fact is that, under the influence of the famous geometer Luis A. Santaló (Girona, 1911- Buenos Aires, 2001), professor at the University of Buenos Aires and Argentina's citizen by adoption after his exile from Spain because of the Civil War, I was not happy with the strong 'bourbakism' then prevailing at Spanish universities; Santaló was recognized as the world's leader of Integral Geometry. Hence and from my beginning as a researcher, I did search for topics with some relationship with reality, and I was fortunate by meeting them in the Probabilistic Metric Spaces of Menger, and later on the Fuzzy Logic of Zadeh.

4 The big jump

4.1.

Once I decided, at the end of 1975, trying to investigate on fuzzy sets, I started reading papers on the subject and very soon my attention was called up by the concept of 'fuzziness' that, not existing with sets, was new for me and show, specially, the important aspect of its measurability allowing to distinguish it from the philosophical term 'vagueness' with which it is again confused. The idea of fuzziness come to me from the 'indices of fuzziness' in the book of Arnold Kaufmann and, newly, it conducted me to a paper, the 1972 on 'non-probabilistic entropy' by Aldo de Luca, and Settimo Termini that made me realize that fuzziness can be measured and that, consequently, it is not a metaphysical concept. I certainly owe a big gratitude to Kaufmann's book since it impelled me to early know Zadeh and Termini papers, as well as to be later on and personally acquainted with both of them.

In 1976 the opportunity of organizing in Barcelona, and in July 1977, the 'First World Conference on Mathematics at the Service of Man', opened me the possibility of inviting Zadeh to deliver a main speech in it, as well as to opening to some Spaniards the opportunity of presentation of their first

papers on fuzzy logic. These people were Miguel Delgado, from the University of Granada, and me that, respectively, did contribute with papers on the concept of fuzzy-function, and on that of fuzzy entropy.

4.2.

Let me stop for a while in how Miguel Delgado was interested in fuzzy logic, since it reveals something that, from its very beginning, characterized this definitive step that, in particular, allowed Lotfi Zadeh to be acquainted with Spain, a country to which he returned many times in the following thirty years, and where he is both respected and loved. The second World Conference on Mathematics at the Service of Man was held in June, 1982 and at the Technical University of Las Palmas in the Canary Islands, and also counted with nice communications related with fuzzy logic. Nevertheless, it was already out of the period 1974-1980.

During the summers of 1975 and 1976 I did organize in the Technical University of Catalonia in Barcelona, a seminar called 'For the Initiation into Mathematical Research', to show new open tendencies to young people aiming at becoming researchers. These seminars were attended by many people, among which Miguel Delgado and his wife Amparo Vila from Granada, bright as some of the most enthusiastic attendants, and where both knew something on fuzzy logic. The idea for these seminars came to me from those organized in an American University and on which Karl Menger, lecturer in them, told me about. Such seminars resulted a good occasion to animate young researchers to start working in Generalized Metric Spaces[11], then my main line of research, and to let know fuzzy logic to mathematicians as a new and promising line of research in which many topics were deserving to be explored.

To disseminate new and open possibilities of research is, from then, a main characteristic constantly shared by those that start working in fuzzy logic from the last seventies of XX Century. In some years ahead it resulted in the establishment of several 'schools' of research that, under the leadership of some brave university professors, is what conducted Spain to a good international position first in fuzzy logic, and after in soft computing. In this way, the old type of a personal and isolated work earlier done by Deaño, and Azorín, was substituted by that of teams well intercommunicated with other teams around the world, and fuzzy logic benefited from many Ph. D. Dissertations written inside these teams, and its study did spread all around Spain as a prestigious subject of research.

5 Conclusions

5.1.

Many young doctoral students joined me in Barcelona, and Delgado in Granada. Simultaneously I entered in contact with people whom, in the 'Laboratoire d'Automatique et Analyse de Systemes (LAAS)' in Toulouse (France), and under Joseph Aguilar-Martin, were also interested in Fuzzy Logic, as it is Ramon López de Mántaras who, after doing in Toulouse his 'Thèse de Troisième Cycle' in which he used fuzzy sets, did a stay in Berkeley to study a Master and was working there under Zadeh. These contacts with the LAAS allowed me to be acquainted there with Michio Sugeno in the Fall of 1976, to know his 1974 Ph.D. Disssetation [12], and to invite him to visit both Barcelona and Granada in January 1977. Both Zadeh and Sugeno resulted, not only by their work but also personally, very influential in the future of fuzzy logic in Spain. Probably, we owe to the personal character of Zadeh the fact that our community of 'fuzzy researchers' always enjoyed an excellent level of friendship. It also deserves to be mentioned what, soon after 1980 up to today, and concerning areas related with fuzzy systems, Spanish researchers also owe to Claudio Moraga, professor at the Dortmund Technical University after his forced exile from Chile because of Pinochet 'coup d'etat', who not only through his work but also personally, influenced many of them in at least Barcelona, Granada, and Santiago de Compostela.

Finally, already in 1980, I published my first book on fuzzy sets, 'Conjuntos borrosos' (Fuzzy Sets)after publishing alone, in 1979, the paper that opened a line of research that I did continue for many years, the study of non-distributive forms of the connectives 'and' and 'or'. In this 1979 paper, whose title is 'Sobre funciones de negación para la teoría de conjuntos difusos' ('On Negation Functions for Fuzzy Set Theory'), and following a paper by Robert Lowen, I characterized all strong negation functions by means of solving a functional equation, a methodology I did learn when studying Probabilistic Metric Spaces and that, later on, with Claudi Alsina (who did his Ph. D. Disssertation on Probabilistic Metric Spaces under me and after being one year with Bert Schweizer in Ahmerst, Mass.) we did successfully apply to the study of the Aristotelian forms in fuzzy logic; up to the first decade of this Century, we jointly published more than seventy papers. The first of these series of papers devoted to connectives, and also co-authored with Alsina and me by Llorenç Valverde, was presented in 1980 in a conference in Barcelona with the title 'On non-distributive logical connectives for fuzzy set theory'[14]; in it the t-norms and t-conorms, we knew from our prior study of Probabilistic Metric Spaces,

were introduced in Fuzzy Logic. In that previous time, but already in 1981, I did introduce again in fuzzy logic a new concept also coming from Menger, that of T-Indistinguishability Operators [15], furtherly developed by some researchers the first of which were, among others, and not only in Spain, Llorenç Valverde and Joan Jacas in Barcelona. The Menger's trace in theoretic fuzzy logic is actually relevant, and I well remember what, in 1976 and in Chicago, Menger told me after regretting that Zadeh did not know on his hazy sets: 'Were Abraham Wald not passed away in the aircraft accident in India, today the subject would be an important one in mathematics'. In my view, it is a pity that up to today no 'famous' mathematician have been actually and deeply interested in Zadeh's ideas, and further than the more or less elemental mathematical models describing something of potential interest, and by taking into account that those ideas neither particularly refer to artificial languages, nor to formal deductive reasoning, but to the nuances of natural language and commonsense reasoning.

5.2.

After 1980, and as it has been said, people like (to quote but a few) the before cited Amparo Vila, and José Luis Verdegay in Granada, and in Barcelona people like Claudi Alsina, Francesc Esteva, Teresa Riera (who presented her Ph.D. Dissertation in 1981), and Llorenç Valverde (Ph. D. Dissertation in 1982), joined Delgado and me, and the way to future steps was definitively open.

In such a way, and between the first and the last eighties, it should be remarked the importance that meant the creation of two centers focalizing the research on fuzzy logic and related areas in Spain, and from which the research on fuzzy logic spread all around the country in different universities and departments. They were the Department of Computer Science and Artificial intelligence (DECSAI) at the University of Granada, and the Section of Artificial Intelligence at the Centre for Advanced Studies in Blanes (Spain), belonging to the CSIC (Spanish High Council for Scientific Research) that, later on, was converted in the today well known Institute for the Research in Artificial Intelligence (IIIA), placed close to Barcelona.

5.3.

In sum, if Deaño, Azorín and Trillas can be considered as those that are responsible of firstly introducing fuzzy logic in Spain, the unfortunate passing away of the two first caused that only the third could count with a possibility for going ahead. It was thanks to the job of people like Delgado, Vila, Verdegay, Alsina, Esteva, López de Mántaras, and many others. It is from all of them that the posterior work in fuzzy logic continued after several generations of researchers directly coming from those pioneers.

6 Acknowledgements

This paper is dedicated to those who most influenced my thought, in particular, to the late Karl Menger, and the late Luis A. Santaló. But, and especially to Lotfi A. Zadeh, and as a humble way of showing him my deepest acknowledgment for what I directly owe him through a friendship already lasting for almost forty years.

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