Archives for the Philosophy and History of Soft Computing

Issue 1/2017

INTERNATIONAL ONLINE JOURNAL OPEN ACCESS

ISSN 2341-0183

The Gradual Arrival of Fuzziness in Switzerland

Edy Portmann [1]

[1] University of Bern, Engehaldenstrasse 8, CH-3012 Bern, Switzerland

Email: edy.portmann@iwi.unibe.ch

Abstract Switzerland is renowned for many things: the mountains, Heidi, chocolate, bank accounts, the punctuality of public transport and, of course, (pretty expensive) high quality watches. However, Switzerland is probably most famous for exactness and accuracy, influencing Swiss mentalities and everyday life. Legend has it, that is to say, that in Switzerland you can set the watch by the trains – something unheard of in any other European country. Perhaps for this reason, in Switzerland it was especially difficult to take up concepts such as the fuzzy set theory developed by Lotfi Zadeh. Nevertheless, fuzzy set theory found its way into Swiss computer sciences, too, jolting the beliefs and convictions of Swiss scientists. The slightly belated gradual arrival of fuzziness in Switzerland is the topic of this article.

1 Introduction

Switzerland is renowned for many things: the mountains, Heidi, chocolate, bank accounts, the punctuality of public transport and, of course, (pretty expensive) high quality watches. However, Switzerland is probably most famous for exactness and accuracy, influencing Swiss mentalities and everyday life. Legend has it, that is to say, that in Switzerland you can set the watch by the trains – something unheard of in any other European country –, and that a minor delay of a local train can make it into the newspapers. Precision is the key to the sophisticated workmanship of the Swiss watchmaking industry, and accurate clocks are unquestionably vital to a reliable public transport system. To sum up: Attributes such as accuracy, exactness, and reliability are held in high esteem all over Swiss society and are supposed to be part of a particular Swiss national and cultural identity. This contributes to a profound uneasiness about things or ideas that cannot be detected by measurement or will not be described appropriately by the means of preciseness. Similarly, the scientific disciplines of the Swiss research community, especially the natural and social sciences as well as engineering and computing, tended (and still tends) to underestimate factors and phenomena that cannot be described adequately by anything else but terms and models relying on exactitude and unequivocalness. Of course, this does not apply only to Swiss researchers, but, apparently, in Switzerland it was especially difficult to take up concepts such as the fuzzy set theory developed by Lotfi Zadeh. As we all know, this theory takes into account a distinct logic of vagueness, inexactness, uncertainty and indetermination [Zadeh, 1965], which seems to be diametrically opposed to a quite static view of the world based on accuracy.

Nevertheless, fuzzy set theory found its way into Swiss computer sciences, too, jolting the beliefs and convictions of Swiss scientists – albeit rather late as in the most European countries the reception of Zadeh's ideas started much earlier [Seising & Arguelles Mendéz, 2015; Seising, 2005; Seising, 2009]. This slightly belated gradual arrival of fuzziness in Switzerland is the topic of this article. Based on the example of the Swiss Academy of Natural Sciences, the first part takes a look at the history of accuracy in Swiss research. The second part focuses on the fuzzy pioneers in Switzerland. Referring to the Swiss service industry, the third part elaborates on fuzzy marketing and management research, currently gaining traction in Switzerland. A brief conclusion completes this short history of the propagation of fuzzy set theory in Switzerland.

2 Accuracy and the Beginnings of the Swiss Natural Sciences

In 2015, the Swiss Academy of Natural Sciences, the oldest national scientific organization of the country, commemorated its 200-year anniversary [Kupper & Schär, 2015]. In 1815, the founding year of the Swiss Confederacy, cosmopolitan Swiss patriots and aficionados came together to establish this institution [Hupfer & Schär, 2015]. This was not the only academy of (natural) sciences that was founded in Europe between the first half of the 18th century and 1900 [Sellin, 2010]. This movement resulted from the emergence of the natural sciences that developed in the course of the Enlightenment from the traditional natural history that influenced the exploration of the world since Pliny's Naturalis Historiae [Jaeger, 2015]. These institutions, however, were not only supposed to house the new sciences, but also to further the nation's reputation and the building of a common civic identity – especially in the 19th century, the so-called Century of the Nation States.

This political, social and cultural background also explains why the first big project that was initiated by the Swiss Academy of Natural Sciences in 1820 was devoted to create exact geographical maps that were supposed to cover all parts of Switzerland [Hupfer & Schär, 2015; Kupper & Schär, 2015]. Here, too, the Swiss were not the only one as cartography – the topographical measuring of a partly still unknown world – was an exciting research field that attracted in many countries lots of men. To map Switzerland, very probably a triangulated mesh had to be formed. With the Topographic Maps of Switzerland – a series of 1:100 000 scale map, published from 1845 to 1864 – the young state was recorded comprehensively for the first time. Some years later, initiated by the International Geodesy Project, the Swiss Geodesic Commission reassessed the maps and found them insufficient. Therefore, the commission induced a revision resulting in very accurate three-dimensional models of Switzerland's topography [Hupfer & Schär, 2015]. Since, Swiss cartographers acquired a reputation for very good and precise maps. And perhaps it is no coincidence that important elements of the much frequented, granular-computing-based web-service Google Maps were developed by computer engineers in Switzerland – about 150 years after the first publishing of the Topographic Map of Switzerland [Allen, 2008].

The formation of a professional Swiss cartography since the 19th century is an interesting example illustrating the connection between accuracy and Swiss identity, right at the beginning of the history of the natural sciences in Switzerland as well as of Switzerland itself as a nation. Partly, this process is typical for the most European countries in the 19th century,

especially of those states that at that time only had started to build up a collective national identity of their own. In the case of Switzerland, however, the combination of accuracy and identity is particularly striking and persistent. Until today, accuracy, exactness, and reliability are supposed to be intertwined closely with "Swissness", a very adaptable, ambiguous term that is criticized frequently and harshly as 'mere' marketing phrase to sell Swiss products and services [Feige et al., 2010; Tanner, 2015]. Nonetheless, it is also part of Swiss self-perception (or at least self-display), and this may be one of the reasons why it is not be surprising that accuracy dominated Swiss scientific belief systems for more than 175 years after the establishment of the Swiss Academy of Natural Sciences.

But as it was said before: It took a little bit longer, but finally fuzzy set theory found its way into Swiss computer sciences. In the 1980ies and 1990ies researchers as Horst Bunke (University of Bern) and Jürg Kohlas (University of Fribourg) started to defy the paradigm of accuracy. Their dedication was the starting point for the Espace Mittelland region of Switzerland, encompassing the BeNeFri-Universities Berne, Fribourg, and Neuchâtel, to become the most prolific fuzzy region of Switzerland as it is today [Kohlas, 1992a, Kohlas, 1992b; Kohlas, 1992c].

3 Defying Accuracy: The Fuzzy-Pioneers in Switzerland

A pioneer of applied fuzziness in Switzerland is Horst Bunke. In 1979 he accomplished his doctorate, in 1985 the habilitation in computer science at the University of Erlangen (Germany), where he also was a member of the scientific staff, interrupted by postdoctoral studies at Purdue University (USA). In 1984, Bunke became professor of computer sciences at the University of Bern. There he was until his retirement in 2011 head of the research group "Computer Vision and Artificial Intelligence," with pattern recognition as his main research field [Riesen & Bunke 2015; Bunke & Riesen 2011]. In this context he also dealt with applied fuzziness [Dick et al. 2004; Schneider et al. 2001] and, especially, with fuzzy pattern recognition [Bunke & Kandel 2001; Kandel et al. 1997].

Some isolated research activities regarding the application of fuzzy set theory in the Swiss computer sciences took place at the Swiss Federal Institutes of Technology in Lausanne and Zürich (e.g., [Stoop et al, 2002]). However, the most fertile ground for fuzziness in Switzerland is the department of informatics at the University of Fribourg, founded in 1958 and thus the oldest university institute for information and computer sciences in Switzerland [Kohlas, 2008]. At the interface between the Faculty of Mathematics and Natural Sciences and the Faculty of Economics and

Social Sciences, the department conducts pure (i.e., information theory and mathematics) and applied research (i.e., design and engineering) in computer sciences and information systems. Unaware of Lotfi Zadeh's efforts in the 1960ies to found computer sciences as a discipline, the department of informatics at the University of Fribourg adapted his 'degrees of containment' in informatics by intuition [Zadeh, 1968].

At the beginning of the 1990ies, Jürg Kohlas, professor on theoretical computer sciences, and his colleagues at Fribourg took part in the European research project "Defeasible Reasoning and Uncertainty Management" [Kohlas, 1992a], founded as a collaboration of several European universities and other research institutions. This project was a large-scale research project looking into aspects of uncertainty in artificial intelligence [Besnard et al., 1993]. Thus, Kohlas and his fellow scholars became probably the first computer scientists in Switzerland doing research on fuzziness. Their work was the starting point and prepared the ground for a new generation of fuzzy researchers, not only at the University of Fribourg.

One of them is Kilian Stoffel, who – after postdoc-studies at the University of Maryland and the Johns Hopkins University in Baltimore – became full professor at the University of Neuchâtel in 1997. He firstly came into contact with fuzzy research at Fribourg where he obtained a PhD in information systems [Stoffel et al. 1993]. Recently, he pursues research on pragmatic applications of fuzziness, for example regarding to clustering or multi-criteria decision analysis [Stoffel et al., 2010; Albertetti et al., 2016].

Another protagonist, thereby, is the doctoral advisor of Stoffel; Béat Hirsbrunner established the "Pervasive and Artificial Intelligence Research Group" at the Faculty of Mathematics and Natural Sciences after his arrival at the University of Fribourg in 1986 [Kohlas, 2008].

However, the most important impact on the dissemination of fuzzy set theory as a field of research in Switzerland had the mathematician and computer scientist Andreas Meier who joined the Faculty of Economics and Social Sciences at the University of Fribourg in 1999. Next to other important projects in databases and web systems, Meier and his team introduced fuzzy marketing and management as a new research topic in Swiss information and computer sciences.

4 Fuzzy Marketing and Management Research: A new Perspective on Applied Fuzziness

In 2008 their activities in this field resulted in the foundation of FMsquare, a new research center on Fuzzy Marketing Methods at the University of Fribourg [Meier, Bambauer-Sachse & Donzé, 2009]. FMsquare is mainly

engaged in applying the notion of fuzzy sets to business and social challenges as in marketing and management. At the beginning, its main focus lied at marketing, but recently the center extended this perspective to management in general.

Today, data is said to be the new oil, but due to the growing information overload, it has become very difficult to analyze the huge amounts of data and to generate appropriate management decisions. This problem increases even more as lots of data are imprecise and include both quantitative and qualitative elements. Therefore, FMsquare attempts to extend traditional decision making processes by adding intuitive reasoning, human subjectivity and imprecision.

The FMsquare focus on innovative marketing and management issues is surely quite unique in the fuzzy community – not only in Switzerland but also internationally. Particularly for Switzerland, however, as an economy with a strong banking, insurance and service sector, such a research center appears key. So, to have best possible impact in society, as a consequence, the FMsquare research center zeros-in exactly on marketing and management challenges. To this end, in addition to research, the center works also closely with business and government (e.g., for building cognitive cities-to-be [Finger & Portmann, 2016]).

Several studies in this new research field were released since the foundation of the center. In 2008, preceding the founding of the Fmsquare within an inch, Nicolas Werro published a PhD-thesis dealing with fuzzy classification of online customers [Werro, 2008]. Other PhD-studies followed soon: In 2012, Edy Portmann developed a fuzzy grassroots ontology for online reputation management [Portmann, 2012], Michael Kaufmann an inductive fuzzy classification for marketing analytics [Kaufmann, 2012], and Daniel Fasel a fuzzy data warehousing method for performance measurement [Fasel, 2012]. In 2014, Luis Terán introduced a fuzzy-based recommender system architecture for smart participation [Terán, 2014]. Further doctoral theses are well on track already to be completed successfully over the next year.

In 2012, Meier and Portmann started together with Witold Pedrycz – professor at the University of Alberta, Canada, department of electrical and computer engineering, and former president to the North American Association for Fuzzy Information Processing and the International Fuzzy System Association – "Fuzzy Management Methods," an international book series, to establish a new publication medium for this emerging research field. In 2013, after spending his postdoc-studies at Berkley University (on invitation by Lotfi Zadeh), Edy Portmann accepted an assistant

professorship of information science at the University of Bern. The promotion of Swiss research on fuzziness is an important concern to him, wherefore he takes much interest in the intensification of the BeNeFri-research cooperation. Organized by Meier, Stoffel and Portmann, in late September 2016, the first International Conference on Fuzzy Management Methods (ICFMsquare 2016) took place in Fribourg. In the future, this conference is planned as an annual event with alternating locations in the BeNeFri-network. Additionally, this year also the FMsquare Foundation has been founded. This non-profit organization is dedicated to the application of fuzzy set theory on business and management [Stiftung FMsquare, 2016]. To conclude: With Fribourg as core, the BeNeFri-universities will continue to conduct humanistic (management) research based on fuzzy set theory to progress business, society and, thereby, all involved stakeholders.

5 Conclusion: Addressing Accuracy with the Principle of Incompatibility

This article gave an overview of the history of fuzzy research in Switzerland. The aim was to illustrate the history and the development of this promising research-field as well as its past, present and future contributors. Thereby, the shortness of this article does not only reflect the fact that this author is not an historian, but also that the history of fuzziness in Swiss computer sciences itself is still short indeed: Fuzzy research in Switzerland has only but started, and it remains a research-challenge that is worth to be pursued.
This article strives to do this, focusing on Swiss economy and society. Thereby the ‘principle of incompatibility’ [Zadeh, 1973] that proves itself as a corner stone of fuzzy sets theory is followed: It reveals the necessity of applying fuzziness to be able to understand and explain (social) reality. As fast as the social, cultural, political and economic complexities increase, the more precise categorical statements lose meaning and meaningful statements cease to be precise and categorical. Therefore, the principle plays a critical role in the promotion of fuzzy marketing and management methods in (accurate) Switzerland. Challenges of common concern have neither ultimate precisely defined answers nor unique scientific solutions. To deal with, Switzerland’s growing fuzzy community must develop an ability for a broad vision, encompassing large variety of different images, attitudes, and opinions. Then this research-challenge will certainly be successful.
A big thanks goes to Horst Bunke and Jürg Kohlas for their valuable information on the history of fuzziness in Switzerland. Both of them had, so to speak, a seat at the front-row and they readily shared their perceptions.

Finally, Astrid Habenstein helped me to interpret history, what needs to be appropriately owed at this place, too.

Figure 1: Lotfi A. Zadeh and Edy Portmann at the IEEE Summer School on Semantic Computing 2010, University of California, Berkeley, Berkeley, USA

References

1. M. Allen, 2008: "Zoogler" revolution gains momentum. Online: http://www.swissinfo.ch/eng/-zoogler--revolution-gains-momentum/982694 (accessed June 15 2016).

2. F. Albertetti, L. Grossrieder, O. Ribaux, K. Stoffel: *Change points detection in crime-related time series: a fuzzy approach based on a shape space representation*. Applied Soft Computing, Volume 40, March 2016, pages 441–454.

3. P. Besnard, Y. Moinard, W. Pereira, M. Clarke, & N. Wilson: *Journal of AI Communications*, Volume 6 Issue 1, March 1993, pages 27-46.

4. H. Bunke and A. Kandel, editors. Neuro-Fuzzy Pattern Recognition. World Scientific, 2000.

5. H. Bunke and K. Riesen. *Recent advances in graph-based pattern recognition with applications in document analysis*. Pattern Recognition, 44(5):1057–1067, 2011.

6. S. Dick, A. Meeks, M. Last, H. Bunke, and A. Kandel. *Data mining in software metrics databases*. Fuzzy Sets and Systems, 145:81–110, 2004.

7. D. Fasel, 2012: *Concept and implementation of a fuzzy data warehouse*. Thèse de doctorat, Université de Fribourg, 2012.

8. S. Feige, P.M. Fischer, and S. Reinecke, 2010: Swissness Worldwide 2010 – Internationale Studie zur Wahrnehmung der Marke Schweiz. Institut für Marketing und Handel, Universität St. Gallen, St. Gallen: 2010.

9. M. Finger and E. Portmann, 2016: What are Cognitive Cities? In: Towards Cognitive Cities: Advances in Cognitive Computing and its Application to the Governance of Large Urban Systems. Berlin, New York: Springer.

10. F. Hupfer and B. Schär, 2015: Vernetztes Wissen, vernetze Schweiz: Ein Streifzug durch 200 Jahre SCNAT. Online: http://www.naturalsciences.ch/service/publications/43020-vernetztes-wissen-vernetzte-schweiz (accessed June 15 2016).

11. L. Jaeger, 2015: Die Naturwissenschaften: Eine Biographie, Berlin: Springer Spectrum.

12. A. Kandel, Y.Q. Zhang, and H. Bunke. A genetic fuzzy neural network for pattern recognition. In Proc. 6th IEEE Conf. on Fuzzy Systems, pages 75–78, 1997.

13. M. Kaufmann, 2012: *Inductive fuzzy classification in marketing analytics*. Thèse de doctorat, Université de Fribourg, 2012.

14. J. Kohlas, 1992a: Fuzzy Logic: Die Darstellung und Verarbeitung vager Informationen. SEV ASE Bulletin, 1/1992.

15. J. Kohlas, 1992b: Wahrscheinlichkeiten und kausales Schliessen: Darstellung und Verarbeitung von ungewisser Information. SEV ASE Bulletin, 9/1992.

16. J. Kohlas, 1992c: Zuverlässiges Schliessen mit unzuverlässigen Argumenten: Eine Einführung in die Evidenztheorie. SEV ASE Bulletin, 13/1992.

17. J. Kohlas, 2008: Eine kleine Geschichte der Informatik an der Universität Freiburg. Festschrift zum 50-Jahr Jubiläum.

18. P. Kupper and B. Schär, 2015: Die Naturforschenden: Auf der Suche nach Wissen über die Schweiz und die Welt, 1800-215, Baden: hier+jetzt.

19. A. Meier, S. Bambauer-Sachse, and L. Donze, 2009: FMsquare: Research Center of Fuzzy Marketing Methods. Flyer.

20. A. Meier, W. Pedrycz, and E. Portmann, 2012: Fuzzy Management Methods, Springer.

21. E. Portmann, 2012: *The FORA framework: a fuzzy grassroots ontology for online reputation management*. Thèse de doctorat, Université de Fribourg, 2012.

22. K. Riesen, H., Bunke: Estimating graph edit distance using lower and upper bounds of bipartite approximations, Int. Journal of Pattern Recognition and Art. Intelligence, published online, February 2015, DOI: 10.1142/S0218001415500111

23. M. Schneider, H. Bunke, and A. Kandel. Using fuzzy logic to match strings in documents. Int. Journal of Intelligent Systems, 16:609–619, 2001.

24. R. Seising & L. Arguelles Mendéz 2015: Accuracy and Fuzziness. A Life in Science and Politics: A Festschrift Book to Enric Trillas Ruiz, Studies in Fuzziness and Soft Computing Vol. 323, Berlin, New York: Springer.

25. R. Seising, 2005: Die Fuzzifizierung der Systeme. Die Entstehung der Fuzzy Set Theorie und ihrer ersten Anwendungen - Ihre Entwicklung bis in die 70er Jahre des 20. Jahrhunderts. Stuttgart: Franz Steiner Verlag (Boethius: Texte und Abhandlungen zur Geschichte der Mathematik und der Naturwissenschaften Band 54)

26. Seising 2009: R. Seising (ed.), Views on Fuzzy Sets and Systems from Different Perspectives. Philosophy and Logic, Criticisms and Applications. Studies in Fuzziness and Soft Computing Vol. 243, Berlin: Springer 2009.

27. V. Sellin, 2010: Das Europa der Akademien, Heidelberg: Universitätsverlag Winter.

28. K. Stoffel, I. Law and B. Hirsbrunner, *"Fuzzy Logic Controlled Dynamic Allocation System"* IJCAI'93 (13th Int. Joint Conference on Artificial Intelligence), Chambéry, France, August 28 - September 3, 1993; pp. 104-109.

29. K. Stoffel, D. Han and P. Cotofrei, *"Fuzzy Methods for Forensic Data Analysis"*, Integration Techniques in Computational Forensics (ITCF'2010), Proceedings of International Conference SoCPaR 2010, pp. 23-28.

30. R. Stoop, J. Buchli, G. Keller, & W.-H. Steeb (2003): Stochastic resonance in pattern recognition by a holographic neuron model. Physical Review E 67, 061918, 2003 .

31. Stiftung FMsquare, 2016.

32. J. Tanner 2015: Geschichte der Schweiz im 20. Jahrhundert, München: Beck.

33. L. Terán, 2014: *SmartParticipation: a fuzzy-based recommender system for political community*-building. Thèse de doctorat, Université de Fribourg, 2012.

34. N. Werro, 2008: *Fuzzy classification of online customers*. Thèse de doctorat, Université de Fribourg, 2012.

35. L.A. Zadeh, 1965: *Fuzzy Sets*. Information and Control, 8, 338-353.

36. L.A. Zadeh, 1968: *Computer Science as a Discipline*. Reprinted from Journal of Engineering Education, Vol. 58, No. 8, April 1968.

37. L.A. Zadeh, 1973: Outline of a new approach to the analysis of complex systems and decision processes, IEEE Trans. SMC, SMC-3 (1), January, 1973, pp. 28-44.