

Preface

Erich Peter Klement got interested in fuzzy set theory already in the 1970s while being a young Assistant Professor at Johannes Kepler University in Linz, Austria. In 1979, he stayed with Lotfi A. Zadeh at Berkeley University as a Visiting Research Associate, several other research visits to universities in Europe and the United States followed. It was also in 1979 when, together with Ulrich Höhle and Robert Lowen, he first organized the “International Seminar on Fuzzy Set Theory” in Linz. At that time, he could not know that there would be more than 35 seminars to follow, well-established and widely known to the scientific community as the “Linz Seminars on Fuzzy Set Theory”.

Organizing and hosting the seminars for so many years has not only been a great service to the community but also had a big impact on the evolvement of science dedicated to this field. The philosophy of the seminar has always been to encourage critical discussions on mathematical aspects of fuzzy set theory by bringing together researchers from different fields. Those, sometimes even controversial, discussions have helped to develop a common understanding of the treatment of fuzzy sets and fuzzy logic. And it happened more than once, in particular after the fall of the Iron Curtain, that researchers from different countries first met in person on the occasion of one of the Linz seminars.

It has also been during the early 1990s that Peter Klement founded the Fuzzy Logic Laboratorium Linz Hagenberg (FLLL). Through industrial, applied and basic research projects, he provided a working place and research perspectives for (young) colleagues from different countries and disciplines. As the head of the FLLL, and also the Department of Knowledge-Based Mathematical Systems at Johannes Kepler University, he has hosted numerous international researchers within, but also independently of, many research actions such as CEEPUS and COST encouraging again discussions on the theory and application of fuzzy set theory and beyond.

Besides his activities for the scientific community, Peter Klement has always been active as a researcher himself. His early research interests have mainly been devoted to (fuzzy) measures and integrals as several of his articles from the 1980s

prove. Fuzzy measures have also been the background of his close collaboration with the Dan Butnariu leading to the publication of the joint monograph entitled “Triangular Norm-Based Measures and Games with Fuzzy Coalitions” published in 1993.

In 1992, as a result of the first visit of Radko Mesiar and Endre Pap to Linz with an original intention to work on fuzzy measures and integrals, another long time research cooperation, namely on the triangular norms and triangular conorms was established resulting in a lot of journal articles, but in particular in the publication of the joint monograph entitled “Triangular Norms” in 2000. By the intensified work on triangular norms, Peter Klement’s attention had also been drawn to copulas so that since the early years of the new millennium also copulas and quasi-copulas had appeared in the titles of his articles, as well as topics related to aggregation functions leading back to his original research interests in (generalized) integration.

It is therefore not by chance that the current edited volume reflects and covers several aspects of Peter Klement’s research activities. Among the authors one can find former Ph.D. students, former colleagues from the Department of Knowledge-Based Mathematical Systems, as well as colleagues, co-authors, friends of Peter Klement with more than 30 years of experience in fuzzy set theory. Some of the chapters included reflect personal views on traditional topics of the Linz seminar—some of which containing even controversial aspects and fostering a discussion on the mathematics behind. Other chapters deal with deep mathematical theory of the algebraic and logical foundations of fuzzy set theory and fuzzy logic. Several chapters approach topics related to Peter Klement’s personal research interests in copulas, measures and integrals, as well as aggregation problems.

We briefly summarize the single chapters included in this volume:

Siegfried Gottwald has contributed to chapter discussing the main developments in the field of mathematically oriented fuzzy logics and how they found their representation over the years in the Linz Seminars on Fuzzy Set Theory. Let us acknowledge that Siegfried Gottwald had been a regular and active participant to the Linz Seminars since 1990 and we are deeply sorrow that he passed away before the finalization of this edited volume.

Enric Trillas has provided a very individual view on fuzzy sets and their personal and scientific perception since their introduction by Lotfi A. Zadeh in his seminal paper in 1965.

In his contribution “Modules in the Category \mathbf{Sup} ” Ulrich Höhle explains basic properties of left modules on unital quantales with perspectives towards fuzzy set theory and contributes to the clarification of mathematical, in particular the algebraic, basis of fuzzy set theory inside mathematics.

Daniele Mundici elaborates in his chapter a geometric approach to MV-algebras and relates algebraic aspects to the basis of fuzzy resp. many-valued logics.

Francesc Esteva and Lluís Godó discuss the equational characterization of continuous t-norms being an indispensable tool for modelling the semantic interpretation of the intersection in fuzzy logics in narrow sense.

Also Thomas Vetterlein and Milan Petrik focus on the semantics of fuzzy logics by discussing two different ways of investigating totally ordered monoids as an interpretation of the conjunction in fuzzy logics.

Andrea Mesiarová-Zemánková's chapter provides a characterization of the structure of uninorms with continuous diagonal functions. Uninorms may be seen as generalizations of t-norms and t-conorms, as they are associative and commutative increasing operations on the unit interval whose neutral element can be, in contrast to t-norms, respectively t-conorms, any interior element of the unit interval and allow to model also bipolar behaviour in aggregation problems.

Humberto Bustince, Edurne Barrenechea, Miguel Pagola and Javier Fernandez provide an overview on concepts of overlap and grouping functions generalizing ideas of connectives from fuzzy set theory for the aggregation of information in fuzzy classification systems.

Fabrizio Durante and Elisa Perrone in their chapter focus on asymmetric copulas and their application in the design of experiments. The importance of copulas stems from Sklar's theorem clarifying that the dependence of a multivariate distribution function of its univariate marginal distributions is, in case of continuity, completely captured by a unique copula. The asymmetry of a copula therefore reflects the non-exchangeability of the underlying random variables.

Carlo Sempì elaborates in his chapter the relationship between copulas and stochastic processes, in particular the Brownian motion.

Anna Kolesárová and Andrea Stupňanová discuss extensions of capacities to n -ary aggregation functions with relationships to the discrete Choquet and Sugeno integral stressing the role of n -ary copulas when generalizing Lovász and Owen extensions.

Ronald R. Yager approaches a more recent problem in aggregation, namely the problem of multi-source information fusion by using measure representations. The concepts of assurance and opportunity in the measure framework are also discussed.

Michel Grabisch focusses on bases and transforms of set functions on a finite set. The basic duality between bases and invertible linear transforms is established, covering, among others, the case of the Moebius transform, the Fourier transform and interaction transforms.

Siegfried Weber in his chapter deals with conditioning for Boolean subsets, indicator functions and fuzzy subsets. It introduces and discusses two types of iteration.

Endre Pap discusses the integration of multivalued functions from additive to arbitrary non-negative set functions. In particular, a set-valued Gould-type integral of multifunctions is introduced and discussed.

Our special thanks go to our authors for their willingness to contribute to this comprehensive volume. And we hope that the readers will enjoy reading all or part of the chapters.

We congratulate Peter Klement for his scientific achievements and we are thankful for the support he has given to us and to the scientific community in fuzzy set theory throughout so many years. We are happy to witness that, although being retired from being a university professor, he still enjoys being an active researcher.

We wish him all the best, in particular healthiness, for pursuing his goals in the future.

We have been supported by our universities, the Johannes Kepler University in Linz and the Slovak University of Technology in Bratislava. We also gratefully acknowledge the support of the grants APVV-14-0013 and the support in the framework of the Technologie-Transfer-Förderung Wi-2014-200710/3KX/Kai of the Upper Austrian Government, as well as the encouragement and the help of Prof. Janusz Kacprzyk for the preparation of this edited volume.

Linz, Bratislava
November 2015

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On Logical, Algebraic, and Probabilistic Aspects of Fuzzy
Set Theory

Saminger-Platz, S.; Mesiar, R. (Eds.)

2016, XII, 275 p. 20 illus. in color., Hardcover

ISBN: 978-3-319-28807-9