About Rudolf Kruse and His Research Group on Computational Intelligence

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Abstract. The preceeding chapters contain original contributions on the occasion of Rudolf Kruse's 60th birthday. These papers are categorized in the four research areas to which Rudolf Kruse and his research group contributed to, i.e. fuzzy data analysis, hybrid intelligent systems, uncertainty in knowledge-based systems, and intelligent data analysis. Each topic spans one part of this book whereas the corresponding papers are ordered alphabetically by the last name of the first author. The fifth part comprises papers that describe the application of computational intelligence methods to real-world data analysis problems. This gives some more historical insights into the research works of Kruse and his group.

Rudolf Kruse obtained his diploma (Mathematics) degree in 1979 from University of Braunschweig, Germany, and a PhD in Mathematics in 1980 as well as the venia legendi in Mathematics in 1984 from the same university. Following a short stay at the *Fraunhofer Gesellschaft*, in 1986 he joined the University of Braunschweig as a professor of computer science. Since 1996 he is a full professor at the Faculty of Computer Science of the University of Magdeburg where he is leading the computational intelligence research group.

Rudolf is the mentor of 20 doctorates and habilitants. He supervised more than 300 undergrate and graduate students. Since decades, he is giving lectures about a broad topic of computational intelligence methods. His group published many student textbooks in German and

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English on many aspects of computational intelligence. Some of the most known English textbooks are about fuzzy systems [10] and neuro-fuzzy systems [14]. This eventually led to an English student textbook entitled *Computational Intelligence* [12] which appeared in the Springer series *Textbooks in Computer Science* in 2012.

Rudolf has coauthored more than 350 referred papers and 40 books. According to Google Scholar, he has more than 8,000 citations and currently an h-Index of 41. Kruse is associate editor of 10 scientific journals. He is a fellow of the *International Fuzzy Systems Association (IFSA)*, fellow of the *European Coordinating Committee for Artificial Intelligence (ECCAI)* and fellow of the *Institute of Electrical and Electronics Engineers (IEEE)*.

The first research area where Rudolf Kruse and his group contributed to is *fuzzy data analysis*. Its aim is to analyse both *crisp data using fuzzy methods* and *fuzzy data using standard methods*, e.g. statistics. Kruse and his group published the first monograph about fuzzy statistics [7]. Already in Braunschweig, he organized workshops on that topic, e.g. *Fuzzy Systems '93 – Management of Uncertain Information* [11]. Even though it was the first of his interests, it is still lively discussed today, e.g. in the just finished COST Action IC0702 "SoftStat" which focused on the combination of statistics and soft computing.Also, this year from October 4 to 6, Michael Berthold and Rudolf Kruse chair the 6th International Conference on Soft Methods in Probability and Statistics in Konstanz, Germany where fuzzy data analysis will be a major topic. Regarding the industry, Rudolf inspired the development of many applications especially dealing with fuzzy clustering [5], e.g. at the *German Aerospace Center*.

His second research area focuses on *hybrid intelligent systems*. There, typically computational intelligence methods are intelligently combined, e.g. a fuzzy system with an artifical neural network. Such a neuro-fuzzy system [14] encodes the fuzzy rules into the network and uses neural network learning algorithms. They can be used in control [13], classification and function approximation. For the development of a fuzzy idle speed controller together with Volkswagen AG [6], Kruse and his group received the outstanding paper award in *IEEE Transactions on Fuzzy Systems* in 1996. Working together with VW, one of Kruse's student used such a hybrid intelligent system to design an intelligent gear system in the VW New Beatle [16].

Rudolf Kruse also contributed to the research field *uncertainty in knowledge-based systems*. Many contributions have been made by Rudolf Kruse's group to handle uncertainties, vagueness, incompleteness or partial inconsistency. Kruse's monograph [9] on this topic from 1991 was one of the first monographs on Bayesian networks. Nowadays, his monograph about learning and representing graphical models has been already extended and published in a second edition [1]. The ES-PRIT Basic Research Action 3085 (named *Defeasible Reasoning and Uncertainty Management Systems (DRUMS)* focused on these methodologies. Rudolf Kruse's research group was one of 11 European ones that participated in that project. In 1992, he established a forum for these groups with the *European Conferences on Symbolic and Quantitative Approaches to Reasoning with Uncertainty (ECSQARU)*.

The first conference in Marseille, France attracted 140 participants. The conference proceedings are still published at Springer-Verlag every other year. During the time of the DRUMS project, 4 books about this topic had been coeditored by him [8, 2, 15, 3]. Similarly to the DRUMS project, Rudolf Kruse and Giacomo Della Riccia, the last doctorate of Norbert Wiener who is the originator of cybernetics, biannually invited internationally renowned researchers to the picturesque Palazzo del Torso of the Centre International des Sciences Mécaniques (CISM) in Udine, Italy. The revised versions of workshop papers were always published in the series *CISM Courses and Lectures* which resulted into 7 books featuring varying topics.

His group in cooperation with Dornier implemented the most like first Bayesian network in Germany. The research [4] on this topic (see also page 153) let to a successful outsourced company where 5,000 Bayesian networks are used on a daily basis.

Most recently, Rudolf Kruse is mainly interested in *intelligent data analysis*. Here, his focus is on the development of new learning methods and temporal data analysis. This book offers a great collection of research questions dealing with this topic. Most applications he has based his research on stem from collaborations with rating agencies at the *Deutsche Sparkassen- und Giroverband (DSGV)*, Europe's largest automobile club *Allgemeiner Deutscher Automobil-Club e.V. (ADAC)*, Daimler, British Telecom (BT), Siemens, Commerzbank and medical institutes at the University of Magdeburg. The interactive data mining platform *Information Miner* has been established during these cooperations and is still in the main focus of ongoing software development in his group today. It is not only used in lectures to visualize and enhance intelligent data analysis, it is also presented at the international exhibition *CeBIT* in Hannover, Germany every year since 2005. Its presentation enables a lively technology transfer from Rudolf Kruse's working group to both industries and the public sector. He shows the usefulness of the methods by consulting companies that typically deploy parts of his tools to solve real-world problems.

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