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Fuzzy Logic in Artificial Intelligence

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Preface

The Eighth Austrian Artificial Intelligence Conference took place at the Bildungszentrum St. Magdalena, Linz, Austria, June 28-30, 1993. Taking into account the sharply increasing importance of fuzzy logic in many areas of applications, it was decided to focus during this conference on "Fuzzy Logic in Artificial Intelligence".

Out of 34 papers submitted in total, 17 were finally accepted by the international Program Committee for presentation during the conference, all of which are reprinted in this volume. The contributions cover a wide range of areas where fuzzy logic and artificial intelligence meet in current research: theoretical issues, machine learning, expert systems, robotics & control, applications to medicine, and applications to car driving.

In addition to the contributed papers, the conference also featured invited talks by Lotfi A. Zadeh, speaking about "The Role of Fuzzy Logic and Soft Computing in the Conception and Design of Intelligent Systems", and by Irina Ezhkova, speaking about "A Contextual Approach for AI Systems Development". We very much appreciate that both supplied abstracts of their plenary talk for this volume.

Additionally, you will find descriptions of the four workshops that took place during the conference. Johann Gamper and Bernhard Moser organized the "Workshop for Doctoral Students in Fuzzy-Based Systems", Andreas Geyer-Schulz and Peter Kotanczek the one about "Fuzzy Logic for Commercial and Industrial Applications", Rainer Born the one on "Karl Menger, Fuzzy Logic and Artificial Intelligence – An Experiment in Reflection", and Roger Kerr the one on "Fuzzy Scheduling Systems". The conference also included two tutorials, one on "Fuzzy Logic and Applications (in particular to Expert Systems)" by Hans-Jürgen Zimmermann, and one on "Fuzzy Control" by Rudolf Kruse. We are very obliged to all of them for their help in making the conference attractive to all participants.

We are indebted to the members of the Program Committee not only for providing the basis for a fair selection from the initial contributions, but also for many useful comments and suggestions concerning the accepted papers, thus enabling the authors to prepare improved final versions of their contributions.

Finally we would like to thank the supporting companies and institutions and all those persons whose assistance in organizing this conference considerably contributed to its eventual success.

Linz, June 1993 — Erich Peter Klement, Wolfgang Slany

Conference Organizer

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The Role of Fuzzy Logic and Soft Computing in the Conception and Design of Intelligent Systems

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Abstract. The past three years have witnessed a significant increase in the rate of growth of MIQ (Machine Intelligence Quotient) of consumer products and industrial systems.

There are many factors which account for the increase in question but the most prominent among them is the rapidly growing use of soft computing and especially fuzzy logic in the conception and design of intelligent systems.

The principal aim of soft computing is to exploit the tolerance for imprecision and uncertainty to achieve tractability, robustness and low solution cost. At this juncture, the principal constituents of soft computing (SC) are fuzzy logic (FL), neural network theory (NN) and probabilistic reasoning (PR), with the latter subsuming genetic algorithms, belief networks, chaotic systems, and parts of learning theory. In the triumvirate of SC, FL is concerned in the main with imprecision, NN with learning and PR with uncertainty. In large measure, FL, NN and PR are complementary rather than competitive. It is becoming increasingly clear that in many cases it is advantageous to employ FL, NN and PR in combination rather than exclusively. A case in point is the growing number of neurofuzzy consumer products and systems which employ a combination of fuzzy logic and neural network techniques.

As one of the principal constituents of soft computing, fuzzy logic is playing a key role in the conception and design of what might be called high MIQ (Machine Intelligence Quotient) systems. There are two concepts within FL which play a central role in its applications. The first is that of a linguistic variable, that is, a variable whose values are words or sentences in a natural or synthetic language. The other is that of a fuzzy if-then rule in which the antecedent and consequent are propositions containing linguistic variables. The essential function served by linguistic variables is that of granulation of variables and their dependencies. In effect, the use of linguistic variables and fuzzy if-then rules results – through granulation – in soft data compression which exploits the tolerance for imprecision and uncertainty. In this respect, fuzzy logic mimics the crucial ability of the human mind to summarize data and focus on decision-relevant information.

A Contextual Approach for AI Systems Development

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Abstract. The method of context formalization based on fuzzy sets theory is suggested. This leads to the development of contextual systems for flexible decision-making in fuzzy environments. Contextual systems have the following features:

- automatic knowledge generation;
- knowledge interpretation and translation from one context to another;
- knowledge adaptation;
- problem solving in a space of contexts.

The example of application (investigation of Sudden Infant Death Syndrome) is presented.

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Typicality of Concept Instances: a Semiotic Way for its Evaluation

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Abstract. By this paper we first try to determine the reasons for which Fuzzy Set Theory does not comply satisfactory with the expectations of cognitive psychologists. Then, by utilising results whose achievement was treated in earlier papers, it is reported of an attempt to provide for such purpose. To illustrate the presented development and the achieved results, a detailed paradigmatic example is reported.

1. Introduction

One significant application of Fuzzy Set Theory (FST) was supposed to occur in Cognitive Psychology; specifically, in formalising concepts and operations possible on these. Differently, since the initial tentative in the seventies, cognitivists realised that FST was failing to comply with the requirements expected in the obtainable results. This, notwithstanding: 1rst) it was well established that instances did not have equivalent status in representing concepts (e.g. [23; 22]), so that a fuzzy structure was recognised on these; 2nd) the resolution with which, at that time, FST was indicated as possessing the "natural" tools to assess the *typicality* of concept instances, i. e., the goodness of each instance in representing specific concepts[12; 16; 20; 22].

Consequently, to the early tentative of utilising FST in Cognitive Psychology, the cognitivist community reacted by starting a lively debate. This was risen by Kay [13] and went on by others; among these we mention [15; 23; 24; 31]. One of the main objections regarded the inadequacy of FST to evaluate changes of typicality, which may occur when concepts interact among themselves. About this, some researchers even shown that the application of FST operations to concepts may yield contradictory and/or false results, when applied to concepts [19; 23].

2. Cognitivism and FST

The essential remark that can be made to FST, relatively to its possible utilisation in formalising concepts, is summarised in this section.

Any given concept C can be considered as the knowledge that underlies a category $\boldsymbol{C}$: the collection, possibly exhaustive, of the elements that are