

## *Upgrading ideas about the concept of Soft Computing\**

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### **Abstract**

This short note is devoted to introduce the discussion carried out along this special issue on the concept of Soft Computing by key researchers in the field. We shall stress some aspects of the conception and origins of Soft Computing, supported by the scientific relevance of its participants. The contributors will show their own view about a single question, *What is Soft Computing?*, covering answers from a general historical approach to the role of some specific tools within their expertise. This discussion represents an extremely interesting view about the concept of Soft Computing, its meaning, its related techniques and its relationship with close fields.

*Keywords:* Artificial Intelligence, Complex Systems, Computational Intelligence, Computing with Words, Fuzzy Sets, Granular Computing, Machine Intelligence, Soft Computing, Soft Systems, Type-2 Fuzzy Sets.

### **1. Introduction**

*Soft Computing* was introduced by Lotfi A. Zadeh<sup>23,24,25</sup> in the early 90's with the declared intention of covering a family of mathematical models and its related techniques that manage any kind of human uncertainty (including Probability, Fuzzy Logic and other linguistic-based models). But so far, there is no a clear and unique definition for *Soft Computing* that would be generally accepted. Such a lack of a clear definition for *Soft Computing* has soon addressed in the literature<sup>1,6,8,22,26</sup>. In particular, we can find several overlapped terminologies related to *Soft Computing*, like *Soft Systems*, *Computing with Words*,

*Computational Intelligence*, *Machine Intelligence* or *Artificial Intelligence*, and so on.

The fact is that during the last FLINS 2008 conference (Madrid, Spain, September 21-24, 2008) the plenary speaker Luis Magdalena<sup>10</sup>, Head of the European Centre for Soft Computing (Asturias, Spain), gave a talk under the title *What is Soft Computing?* that turned into an intense discussion among key researchers in the field attending Luis Magdalena's talk. The exchange of ideas was so vivid, complementary and illustrative, that we immediately contacted each active participant in such a discussion to write down their comments, in order to put them altogether as a special issue of some relevant scientific journal. Most of those FLINS participants agreed very soon to join this project,

1

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and Da Ruan, founder of the FLINS initiative and that took also part in such a discussion, offered the International Journal of Computational Intelligence Systems for a rapid dissemination of such a wonderful and spontaneous round table, understanding that this project absolutely fitted the objectives of the journal and was within the best FLINS tradition. Some additional author was also invited to participate in this special issue due to their relevance in the topic and with the aim of keeping equilibrium of original positions in Luis Magdalena's session.

**FLINS** stands for **F**uzzy **L**ogic and **I**ntelligent **T**echnologies in **N**uclear **S**cience, an initiative launched by 1994 with the Belgian Nuclear Research Centre (SCK•CEN) with the objective to give PhD and Postdoc researchers the opportunity to carry out future-orientated research<sup>16</sup>. Since then, FLINS objectives have been extended to *Computational Intelligence in Decision and Control*, focusing on the promotion of research related to decision making and control problems for complex systems<sup>17</sup>. In fact, the declared main mission of FLINS is to conduct research on computational intelligence systems for solving intricate problems pertaining to nuclear/power research and related complex systems, bridging the gap between machine intelligence and complex systems via joint research with Belgian, European and international research institutes and universities. International FLINS conferences on computational intelligence systems encourage interdisciplinary research by bringing multi-discipline researchers together. The life discussion that naturally appeared around Luis Magdalena's talk was indeed in the best FLINS spirit and tradition.

## 2. About this special issue

This special issue has been conceived in three parts. Firstly, a general overview stated by Luis Magdalena<sup>11</sup> is complemented with some historical and a crude computational blind analysis. The second part is centred on the complexity and the semantic component of natural intelligence. And the third part offers an alternative approach, focussing more on the sense of the question *What is Soft Computing* rather than the meaning of *Soft Computing* itself.

### 2.1. Part 1: General Overview

The first paper<sup>11</sup> contained in this special issue is the extended version of the FLINS 2008 invited talk of Luis

Magdalena<sup>10</sup>, where the author states that there is no precise and generally accepted definition for *Soft Computing*. Magdalena briefly presents a first analysis of the main definitions of *Soft Computing* that can be found in the literature, developing a first comparative analysis, which leads him to postulate that there is no a significant difference between *Soft Computing* and *Computational Intelligence*, simply based on the relative presence of certain techniques and models.

In the second paper, Rudolf Seising<sup>20</sup> offers a complementary historical perspective of the concept of *Soft Computing*, as introduced by Lotfi A. Zadeh, but linking his approach to the visionary calls of Warren Weaver and Charles Percy Snow towards a new interdisciplinary coming science associated to complexity and humanities, around fifty years ago.

From a *crude* spiking neural network approach, Liam Maguire<sup>12</sup> then navigates across various overlapping terms like *Computational Intelligence*, *Artificial Intelligence*, *Computer Science*, *Intelligent Systems*, *Intelligent Bio-inspired Systems* or *Computational Neurosciences*.

### 2.2. Part 2: Modelling Natural Intelligence

The second part of the special issue starts with a paper of Enrique Ruspini<sup>19</sup>, who stresses the role of complexity of existing mathematical and computational models in the origin of *Soft Computing*, which is viewed as a strategy specifically devised to take advantage of the natural tolerance that imprecision and vagueness introduce in certain kind of problems. Enric Trillas, Claudio Moraga and Sergio Guadarrama<sup>21</sup> then point out the underlying semantical-based *Computing with Words* challenge, studying the relationship between *Soft Computing* and *Machine Intelligence* in order to conclude that a *Soft Computing* implies a re-definition of traditional intelligence. Within this context, Witold Pedrycz<sup>15</sup> focuses on *Granular Computing*, postulating that *Type-2 Fuzzy Sets* as an effective approach to deal with the complex linguistic structure that fuzzy sets requires for their required interpretability. And within the same context, Humberto Bustince<sup>3</sup> stresses how those problems subject to a relatively precise solution make *Interval Type-2 Fuzzy Sets* a future main tool in *Soft Computing*.

### 2.3. Part 3: Complementary Views

The third part of this special issue starts with a Janusz Kacprzyk's paper<sup>7</sup> that from a discussion about the nature of intelligence, postulates that *Soft Computing* is a narrower area than *Computational Intelligence*. After considering the two aspects implied by the word *Soft* and the word *Computing*, this discussion will lead to relate *Soft Computing* to *Soft Sciences* and to enhance Checkland's *Soft Systems Methodology* as a well established approach to complex problem solving.

In addition, Piero Bonissone<sup>2</sup> acknowledges the impossibility of a proper definition for *Soft Computing*, once he shows that such a semantic background suggests a continuously evolving model-builder.

Finally, Da Ruan<sup>18</sup> presents a personal approach to the concept of *Soft Computing* based upon his practical experience in some particular extremely complex practical problems within SCK•CEN, pointing out the necessity of complementariness between new techniques and traditional approaches within real-problem solving.

### 3. Final notes

In this special issue key researchers in *Soft Computing* will enlighten and update some old concepts about *Soft Computing*, providing at the same time new paradigms and trends on the past and future of the field, in relation to close and certainly overlapping fields.

As promoters of this special issue, we want to stress the evident interdisciplinary characteristic of *Soft Computing*. Along this special issue, the authors make clear the deep connection established by Computer Scientists (including Computer Engineers and Mathematicians) to Social Sciences (including Management Sciences, Psychology and other fields where human expertise as decision makers is learnt) and Humanities (including Philosophy and Linguistic Sciences). Still, we should point out that one key piece is missing in the interdisciplinary view achieved in this special issue: Neurobiology, which is amazingly showing how the human brain builds up a decision making process by means of interactive but different machineries<sup>4,5,9</sup>. Computer scientists should devote more attention to the recent and expected findings in this field, in order to learn and create accurate models closer to the way natural intelligence approaches some decision making problems<sup>13,14</sup>.

We sincerely hope that the readers will enjoy this special issue.

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