

Roberto Moreno Díaz
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Computer Aided Systems Theory – EUROCAST 2005

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Revised Selected Papers



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Preface

The concept of CAST, computer aided systems Theory, was introduced by F. Pichler of Linz in the late 1980s to include those computer theoretical and practical developments used as tools to solve problems in system science. It was considered as the third component (the other two being CAD and CAM) that would provide for a complete picture of the path from computer and systems sciences to practical developments in science and engineering.

The University of Linz organized the first CAST workshop in April 1988, which demonstrated the acceptance of the concepts by the scientific and technical community. Next, the University of Las Palmas de Gran Canaria joined the University of Linz to organize the first international meeting on CAST (Las Palmas February 1989), under the name EUROCAST 1989, a very successful gathering of systems theorists, computer scientists and engineers from most European countries, North America and Japan.

It was agreed that EUROCAST international conferences would be organized every two years. Thus, the following EUROCAST meetings took place in Krems (1991), Las Palmas (1993), Innsbruck (1995), Las Palmas (1997), Vienna (1999), Las Palmas (2001) and Las Palmas (2003) in addition to an extra-European CAST conference in Ottawa in 1994. Selected papers from those meetings were published as Springer Lecture Notes in Computer Science vols. 410, 585, 763, 1030, 1333, 1728, 2178 and 2809 and in several special issues of *Cybernetics and Systems: an International Journal*. EUROCAST and CAST meetings are definitely consolidated, as has been demonstrated by the number and quality of the contributions over the years.

EUROCAST 2005 (Las Palmas, February 2005) continued with a new approach to the conferences which was adopted in 2001. Besides the classical core on generic CAST, chaired by Pichler and Moreno-Díaz, there were workshops on Computation and Simulation in Modelling Biological Systems, chaired by Ricciardi (Naples); Cryptography, chaired by Müller (Klagenfurt); Intelligent Information Processing, chaired by Freire (A Coruña); Robotics and Robot Soccer, chaired by Kopacek (Vienna) and Pfalgraf (Salzburg); Spectral Methods, chaired by Astola (Tampere); and Computer Vision and Intelligent Vehicular Systems, chaired by Maravall and García Rosa (Madrid).

This volume contains the full papers selected after the oral presentations of the different sessions. The editors would like to thank all contributors for their quickness in providing their material in hard and electronic forms. Special thanks are due to the staff of Springer Heidelberg for their valuable support.

July 2005

Roberto Moreno-Díaz, Franz Pichler and Alexis Quesada-Arencibia

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On the Physical Formal and Semantic Frontiers Between Human Knowing and Machine Knowing

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Abstract. The purpose of this paper is to reflect on the nature of human knowledge and that of the knowledge that finally can dwell in an electronic computer. Three frontiers can be distinguished between these two constitutively different types of knowing: (1) The nature of current physical machines (silicon semiconductor crystal) and its organizational restrictions in relation with the biological tissue, which is autonomous, dynamic, tolerant to failures, self-organizative, and adaptive. (2) The semantics of the available algorithms and programming languages in relation with the evolutionary and reactive (behavior-based) biological programming strategies. (3) The nature of current formal tools in relation with natural language.

1 Problem Statement

A great part of the AI community attempts to interpret and use concepts of the computational paradigm when applied to natural systems as equivalent to the corresponding concepts when applied to artificial systems. These scientists assume that natural language can be reduced to formal language, that biological programming strategies can be reduced to conventional programming languages and that the nervous tissue and a body of meat can be reduced to a CPU of Silicon crystal and an electro-mechanical robot. Unfortunately, fifty years after the christening of AI at the 1956 summer conference at Dartmouth Colleague, this is not the case. There are relevant, constitutive, differences between Computation in Natural Systems (the human way of knowing) and Computation in Artificial Systems (the machine way of knowing). To contribute to the establishment of a clear distinction between these two different ways of knowing we introduce in section two the methodological building of knowledge [11,9,10], which will enable us to distinguish between three levels and two domains of description of the knowledge involved in a calculus. In sections three, four and five, making reverse engineering, we consider the knowledge that each one of these levels can accommodate, from the physical level to the symbol level and, finally, to the knowledge level. Then we conclude, mentioning the topics in which, in our opinion, we should concentrate our efforts to move the frontiers between human intelligence and machine intelligence.

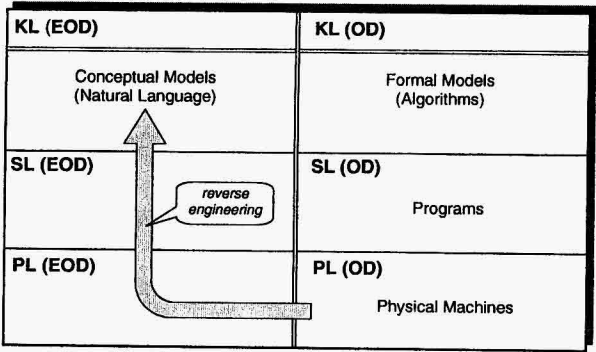


Fig. 1. Reverse engineering in the building of knowledge

2 Direct and Reverse Engineering Inside the Building of Knowledge

The three levels (storey) of the building for knowledge are the physical level where lives the machine hardware, the symbol level where the programs live and the third level, introduced by Allen Newell [12] and David Marr [4], located over the symbol level and named by Newell the knowledge level and by Marr the level of the theory of calculus. Additionally the external observer of a calculus (either in natural or in artificial systems) always can distinguish between two domains of description in each level [6,15,8]: the level's own domain, OD, and the domain of the external observer (EOD), as shown in figure 1.

In direct engineering we start with a conceptual model at the KL and in the EOD of the method used by humans to solve a problem. The architecture of this model depends on the AI paradigm used in our approach (symbolic, connectionist, situated or hybrid). Then we use a table of correspondences to move from this conceptual model to the abstract entities and relations of a formal model situated in the OD of the KL (the 3rd right apartment). Next we program the formal model and a compiler ends the work by producing the final machine language version of the program.

In this formalization process we have left out (in the third left apartments) a great part of the human knowledge used in the conceptual model. This non-computable knowledge establishes the first semantic and formal frontier between human knowing and machine knowing. Only the formal model underlying natural language words enters the computer. The rest of the knowledge always remains in the natural language of the external observer, in the EOD. Obviously the external observer injects this non-computable knowledge when he interprets the results of the calculus (left hand bottom-up pathway in figure 1).

If we now attempt to recover the conceptual model from which this calculus has emerged we have to make reverse engineering, starting on the first right apartment where the program is running in a physical machine, going through the symbol level and ending at the EOD of the KL. In this reverse pathway