



NOTA DEL CURATORE

INTRODUCTION TO THE SPECIAL ISSUE

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In the Summer of 1956 a conference took place at the Dartmouth College, where the name "Artificial Intelligence" was first introduced, and the research areas of "AI" were shaped. So, Artificial Intelligence turns fifty this year!

The initiatives to celebrate the golden anniversary of Artificial Intelligence are very many, all around the world, and also AI*IA decided to join. We are celebrating this anniversary by organizing meetings and events, the most prominent one being the meeting to be held at Riva del Garda at the end of August, co-located with the ECAI06 Conference. We decided also to contribute to the celebrations with the present special issue of our journal "Intelligenza Artificiale."

We propose that a 2 month, 10 man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves.

This is the incipit of the document where McCarthy, Minsky, Rochester, and Shannon proposed to run the Dartmouth Conference. We may say that, after 50 years, the big themes of Artificial Intelligence research are all there, almost identical to those envisaged by the founding fathers.

Even though "human level intelligence" has not yet been reached in any artifact so far, there has been substantial progress that resulted in significant advances in theory and important applications deployed in the most varied environments.

It has been observed that, whenever Artificial Intelligence reaches a new outstanding achievement, this is no longer considered one of its results, but it is transformed,

by some sort of magic, into a product of informatics, or other disciplines. In the meanwhile, many people keep believing that Artificial Intelligence has only produced and still produces "expert systems" realized with a rule based architecture. This has been no more than a software technology used (and abused) in the seventies and early eighties.

The goal of this special issue is to present the reader with a wide spectrum of driving themes and researches that nowadays characterize Artificial Intelligence. We present a snapshot of the research at the international level, with a particular emphasis on Italian research. Of course, we cannot aim at completeness, but certainly we have a good collection of themes and a rich set of references to further reading.

The special issue has been organized in 14 scientific contributions aimed at providing an introduction to the Artificial Intelligence subareas where research has been and is particularly active. We have two more contributions: a retrospective one, that brings our attention back to 1956 and to the cultural milieu where Dartmouth was held, and a contribution on the situation of teaching Artificial Intelligence related courses in Italian universities.

The contributions are organized as follows. First we present some articles on the logicistic approach to Artificial Intelligence, considering both knowledge representation issues and various forms and methods of automated reasoning: [1] Logics for Artificial Intelligence, [2] Automated Reasoning [3] Ontologies and Description Logics, [4] Constraint Programming, [5] Planning & Scheduling, and [6] Automated Diagnosis.

Then we move to the evergreen area of human computer interaction, with a classical topic and a new and promising one: [7] Natural Language Processing and [8] Artificial Intelligence and Entertainment

Machine Learning is a traditional core area of Artificial Intelligence. Classical and new methods are presented in the two articles: [9] Machine Learning and Data Mining, and [10] Kernel Machines, Neural Networks, and Graphi-



cal Models

The contributions then embrace new paradigms for Artificial Intelligence; first the emerging multi agent and multi robots are presented in [11] Multiagent Systems and [12] Artificial Intelligence and Robotics; then evolutionary programming and means to approach complexity conclude the exposition: Genetic and Evolutionary Computation and [14] Complex Systems.

To guide the reader through the special issue, we here report a short abstract for each article, in the words of the respective authors.

1 – Logics for Artificial Intelligence

Logic has been proposed since the early days of Artificial Intelligence as a framework for knowledge representation and reasoning. The article introduces the logicistic approach to Artificial Intelligence by explaining how to build and query a knowledge base of logical formulas representing a domain in the world.

The problems arising when modeling a dynamic and changing world are outlined, as well as those connected with the representation of modalities such as knowledge and belief, time, and so on. Various forms of reasoning are introduced, and finally, the problem of non-monotonicity and belief update and revision are highlighted.

2 – Automated Reasoning

Automated reasoning and knowledge representation are intertwined, as reasoning engines need to take into account representation formalisms, and vice versa. This article surveys both. It covers classical and non-classical logics, illustrating relevant trade-offs between expressiveness and decidability. It summarizes basic principles and results in theorem proving, model building, decision procedures, model checking, logic programming, with applications ranging from verification and reasoning about action to multi-agent systems and web-based reasoning.

3 – Ontologies and Description Logics

Logic based knowledge representation has developed, starting from the late 80s, in two different and complementary directions that cross-fertilize each other. On the one hand, research on ontologies has focused on modeling in logical terms the inherent structure of a domain. This required an intrinsic interdisciplinary approach combining computer science with philosophy and natural language issues. On the other hand mechanisms have been studied, mainly within the area of Description Logics, to draw inferences over such models in an automated way. To achieve effectiveness in practically relevant cases required to pay attention to the fundamental tradeoff between expressive power, influenced by ontological requirements, and computational complexity, determined both by the intrinsic properties of the modeling constructs and by the computational properties of reasoning algorithms. This ar-

ticle analyzes the contribution of Italian and European researchers in the above mentioned two directions.

4 – Constraint Programming

Constraint programming is a powerful paradigm for solving combinatorial search problems that draws on a wide range of techniques from Artificial Intelligence, operations research, software engineering, algorithms and graph theory. The basic idea in constraint programming is that the user states the constraints of a real-life problem, and a general purpose constraint solver is used to solve them. Constraint programming has proven useful in important applications from industry, business, manufacturing, and science. Examples of application areas where constraint programming is now one of the most used technologies are vehicle routing, scheduling, and configuration. However, constraint programming has also been successfully applied to other areas, such as biology, system design, timetabling, resource allocation, etc.

This paper briefly covers the main aspects of constraint programming, including modelling constraint propagation, global constraints, search, hybrid CP-OR algorithms, soft constraints, and applications.

5 – Planning & Scheduling

This contribution aims at creating an entry point to the current research area of Planning and Scheduling in Artificial Intelligence. It introduces the basic planning problem as the problem of synthesizing courses of actions to achieve desired states of the world, and the scheduling problem as the problem of deciding when to allocate actions over time in order to have enough resources available for executing a plan. Then the paper offers a quick overview of state of the art, describing the most important recent achievements, the areas of current research, and the perspective for the immediate future.

6 – Automated Diagnosis

Diagnosis is a very important research area in Artificial Intelligence; an area where various methodologies have been combined and integrated, and where research met applications several times. This paper briefly sketches the evolution of research on diagnosis focusing on the model-based approach which is the most relevant for research and application since the late 80s. The state of the art, the open issues, the research trends are analyzed and the contributions from Italian researchers are singled out.

7 – Natural Language Processing

The paper presents an overview of the research activity in the field of NLP. It introduces the topic by presenting the main subfields that have been investigated, i.e. phonetics, phonology, morphology, syntax, semantics, and pragmatics. The second section describes the major results that have been achieved from a computational point of view.



The paper presents some techniques that enable an automatic system to extract from the input (in written or spoken form) the relevant information about the words, the syntactic structure, the meaning of sentences. Some connections with world knowledge and ontologies are enlightened. The third section introduces methodologies and techniques that are currently in use to solve application problems involving linguistic knowledge. It also shows that the current technology is able to provide the basis for the implementation of tools of high technological value. A concluding section closes the paper by mentioning still open problems.

8 – Artificial Intelligence and Entertainment

Computers are now seen as companions, not only as means for enhancing production. The revolution that started with the advent of the personal computer is leading to another phase. New opportunities are offered to the end user on one hand by ubiquitous computing, with its relation between personal computing and the physical environment, and on the other hand by the web-based integration of all kind of information and processes. This paper gives a picture of the interplay between Artificial Intelligence and entertainment, reporting research in games, entertaining communication, and issues in education.

9 – Machine Learning and Data Mining

Learning has been defined as a set of mechanisms through which an agent improves its behaviour over time and, as such, it is considered a fundamental feature of intelligence. Although computational studies of learning in Artificial Intelligence date back to the 60s, the field started to acquire an autonomous profile only at the end of 70s. Ten years later, studies on Machine Learning also gave birth to a new branch, widely known as Data Mining.

This contribution is meant to trace the origins, to describe the evolution, and to guess the future of Machine Learning and Data Mining, both from the methodological and from the application point of view. The world landscape is outlined and the Italian contribution positioned inside it. Then the paper offers a quick overview of both trends and possible future developments, as well as of links with other AI fields and other disciplines. A section on application achievements and application potential concludes the paper.

10 – Kernel Machines, Neural Networks, and Graphical Models

Further aspects of machine learning are discussed in this article, where the focus is specifically about statistical and probabilistic approaches. The paper briefly reviews the statistical learning setting and some of the state-of-the-art methods including kernel machines, neural networks, and probabilistic graphical models. It also presents methods for learning in structured domains and reviews some classical

application fields of machine learning, such as bioinformatics and natural language processing.

11 – Multiagent Systems

Research on agents and multiagent systems (MAS) has seen a huge expansion in the last years. Many research areas have converged to MAS, and a large number of research fields (from human to social sciences, from biology to economy and law) have contributed to the development of the MAS field. While MAS technologies are developing and spreading worldwide, many complex application scenarios resort to MAS for innovative approaches and solutions.

This paper first tries to devise the current state of the art of MAS research, and to sketch the multifaceted relations between MAS and other research fields. Then, the main application areas for MAS are outlined, and finally some visions on the perspectives of MAS research and technologies are provided. Throughout the paper, while trying to keep a non-biased eye on world-wide research, some emphasis is put to the many relevant results and contributions from Italian researchers in the MAS area.

12 – Artificial Intelligence and Robotics

This article addresses the research carried out in the middle ground between Artificial Intelligence and Robotics. Despite being in between two community makes research success most difficult, the connection between these two fields has played and continues playing a major role. The paper addresses the major scientific issues in the field, namely action, action theory, architectures and perception. Then it looks at the connections and relationships with other topics addressed in this collection, and with other disciplines. Afterwards, the paper presents some application scenarios that have been developed by Italian researchers.

13 - Genetic and Evolutionary Computation

The paper starts by providing a gentle introduction to the field of genetic and evolutionary computation (GEC), particularly focusing on genetic algorithms, for which representations, selection strategies and genetic operators are described, but also touching upon other areas. It then moves on to briefly analyse the state of the art in GEC, in terms of its popularity, its international situation and the position of Italian research and researchers within the field. The authors then discuss open problems and research directions in GEC and present their own interpretation of where and how genetic and evolutionary computation fits in the broader landscape of artificial intelligence research. The applications of GEC are then considered, with particular emphasis on the recent human-competitive results obtained by evolutionary techniques. The paper concludes by making a prediction of the future impact of this technology in the short term.



14 - Complex Systems

This article deals with the interactions between Artificial Intelligence and Complex Systems Sciences (CSS). The notion of complex systems is discussed, and the main properties of such systems are highlighted. In Italy there is an important scientific community active in CSS: a quick overview of European and Italian initiatives is presented. Some of the main research areas and open questions of CSS are examined, limiting to those which are closer to the interests of the Artificial Intelligence community: Agent-based models of social and economic processes, artificial life, emergence of new levels and interaction between levels, top-down vs. bottom-up design, co-evolution and evolvability, complex networks, genetic networks, synchronization, and finally visualization of complex data sets. Important applications of CSS developed in Italy are also mentioned, including: prediction and control of lava flows and landslides, scale-up from the laboratory to the field of interventions of bioremediation of contaminated soil, prediction of properties of rubber tyres and design optimization, modeling of percolation in coffee machines and optimization of the mixture, modeling of cell cultures, and modeling traffic or crowd dynamics.

AI's Half Century: On the Thresholds of Dartmouth

"Artificial Intelligence" turns fifty in 2006. How did it begin? Several differently motivated analyses have been proposed as to its origins. In this paper a brief look at those that might be considered steps towards Dartmouth is attempted, with the aim of showing how a number of research topics and controversies that marked the short history of Artificial Intelligence were touched on, or fairly well stated, during the year immediately preceding Dartmouth.

Teaching Artificial Intelligence in Italian universities

This paper presents the results of a survey about teaching Artificial Intelligence in Italian universities. The survey has been done by sending a questionnaire by email to the mailing list of AI*IA, and storing responses in a database. The results show that teaching Artificial Intelligence is very active, involving dozens of universities, teachers, and courses. More than three thousand students attend a course on and about Artificial Intelligence every year.

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