Book Introduction by the Authors

Invited by

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The Making of a New Science A Personal Journey Through the Early Years of Theoretical Computer Science*

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Before trying to explain what is the aim and the content of this book let me briefly make precise what this book is not. This book is not a history of theoretical computer science. To write such a history would have required a huge effort by a large number of authors. My competence covers only a tiny fragment of our discipline and I believe that no one can be so pretentious to assume to be able to outline even superficially the evolution of all its subfields. Neither, of course, this book is a history of my life. Nobody would care at all about it. This book is indeed an account, a very personal and subjective account, of the world of theoretical computer science as it was developing in front of my eyes since when, in 1965, I started to write my 'laurea' thesis under the supervision of Corrado Böhm. Throughout the years Sixties and Seventies of the last century, while electronic computers, computer programs and computer applications were becoming every day faster and more powerful, assuming a vital role in all human activities (in industry, in economy, in public administration), in US, in Europe, in Japan, a number of scientists, (computer scientists, mathematicians, physicists, engineers) started to formulate fundamental questions regarding computers and computation processes in mathematical terms. Syntactic and semantic correctness of programs, complexity of problems and efficiency of algorithms, correct interaction among concurrent computation processes in a few years became the basic chapters of a new discipline (based on mathematics but reaching out beyond mathematics) and the central focus of research activity in universities, research centers and industrial laboratories. In order to illustrate how this new science has been growing through the years between 1965 and, approximately, 1985 the book develops along three dimensions. First of all the most important subfields of the theory of computing which, during those years, were being defined and addressed and on which research activities were focused: first formal languages and automata, then algorithms and complexity, subsequently semantics, parallel models of computation,

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approximate solution of hard optimization problems, database theory etc. In second place scientific events. Looking back at some of the summer schools and conferences that were being organized in those years we realize their impact in the definition of the most relevant research directions and their role in the building of the scientific community working in theoretical computer science. Finally geography. Starting from the fourth floor of the building of the Italian National Research Council (CNR) in Rome, where I was working on my thesis, the eye explores first the Italian scene, then moves to other European countries (in particular France) and to US. Most important: moving along these three dimensions we meet some of the main scientists that have contributed to the making of the new science, about one hundred gigantic figures who have laid down the foundations of our discipline.

Let us now give a brief outline of the chapters of the book. Chapters 1 ('Tubes') and 2 ('Lots of insipid stupid parentheses') are devoted to my first approach, as a physics student in 1963, to the new exciting world that Corrado Böhm, one of the founding fathers of theoretical computer science, was opening to my eyes and to the topics that the group led by him addressed at the Istituto per le Applicazioni del Calcolo in Rome in the late Sixties (mainly lambda-calculus, combinatory logic, programming languages for symbolic computing). Besides, as we do throughout the book, in order to provide a picture of the status of the 'new science' in those years we give an account of some of the historic events that contributed to disseminating in Europe interest for the mathematical foundations of computer science (e.g. the NATO summer schools in Pisa and Grenoble, mostly devoted, on one side, to formal languages, metalanguages, and compiler construction and, on the other side, to the early studies on program verification and on cooperation and competition between concurrent sequential processes). It is important to notice that most of the great scientists that lectured in those Schools were later assigned the Turing Award.

In Chapter 3 (Counting steps in Cory Hall') I have tried to illustrate the rise of computational complexity studies in US in the late Sixties, seen from my observatory, a very special observatory: the University of California at Berkeley that I was visiting with a CNR fellowship in 1969 and 1970. Just a few years earlier Juris Hartmanis and Dick Stearns had produced their seminal work that established the formal definitions and the basic properties of complexity classes of Turing machine computations and in 1969 in Berkeley I had the chance to attend the lectures of some of the top scientists that have made the history of computational complexity: Manuel Blum (who at that time was developing his elegant abstract computational complexity theory), Steve Cook, Richrd Karp. The incredible atmosphere that could be perceived in Berkeley in those years is well represented in the words of Richard Karp's Turing lecture, reported in the book. Again, in terms of events, those years are characterized by the creation of SIGACT (the

ACM special interest group in automata and computability theory), and, in 1969, by the organization of the first STOC (the SIGACT Symposium on Theory of Computing), since then the major event in the field together with FOCS.

In Chapter 4 ('I hate numerical analysis') we go back to Italy with an attempt to present the major groups of researchers that in the early Seventies were working in theoretical computer science: Naples, where researchers of the Laboratory of Cybernetics of the National Research Council and the Institute of Theoretical Physics of the University were moving from the fuzzy (and sometimes deceiving) world of cybernetics to more precise research issues in automata theory and formal languages; Pisa, that was becoming the capital of computer science in Italy (after the opening of the first degree in Computer Science offered by an Italian university) and where practically all aspects of theoretical computer scince were addressed, with a major role plaied by 'non-numerical' computing; Milan, where the group at the Polytechnic and the group at the Physics Institute were competing in the fields of formal languages and automata theory, and in the new domain of 'software engineering'; and Turin where Corrado Böhm had recently moved and where, of course, lambda-calculus was the dominant research subject. All these groups, including our group in Rome, had stronger collaborations with groups in other countries rather then cooperating with each other. So in the book we also describe our first efforts toward establishing an Italian network of researchers in the field.

Chapter 5 ('Informatique théorique') and Chapter 6 ('The journal') are mainly devoted to the origin of EATCS, of ICALP and of the journal 'Theoretical Computer Science'. The French title of Chapter 5 is a highly deserved tribute to Maurice Nivat, professor at Paris VII and director of research at INRIA. We owe to his vision and energy the creation and the promotion of a European research community in theoretical computer science. In the book the main steps toward the foundation of EATCS are described and an account of the first 'Colloque sur la théorie des automates, des langages et de la programmation' and of the way in which this conference became the major European conference in the field of theoretical computer science is given. A couple of years after the foundation of EATCS Maurice Nivat established an agreement with the publishing house North Holland for the creation of the journal 'Theoretical Computer Science' and in 1975 the first issues of the journal appeared. The journal had a stellar editorial board and some of the papers that were published in the first issues are pillars in the history of theory of computing.

In the subsequent next three chapters of the book, beside continuing to follow the developments of the European research community working in the field of theory of computing (with a look to the progress of EATCS, to the creation and the role of its Bulletin and to the creation of new specialized conferences and scientific events) we have tried to illustrate some of the major research domains

on which the interest of researchers was concentratted in the late Seventies. In Chapter 7 ('Data structures, program structures') we take into consideration the work on structured programming and the algebraic approach to the structuring of data (known as the theory of abstract data types), in Chapter 8 ('Optimization and approximation') we address the study of hard combinatorial optimization problems and their approximability properties and in Chapter 9 ('Relations') we present some aspects of the work related to database theory. In all cases topics and research results are examined in conjunction with some of the scientific events in which such topics had been illustrated to young researchers and that are still remembered as milestones in the history of the field.

Finally Chapter 10 ('Europe strikes back') , the last chapter, is devoted to the beginning of the basic (or long term) research actions that were funded by various institutions in the early Eighties, first in Japan and US and subsequently in Europe with the aim to sustain the strong technological advances in computing that were taking place in those years (with the rise of personal computing, parallel computers, networks, new programming languages, new application domains) with a solid foundational support. In particular such evolution prompted the European Commission to launch the first European research programs in the field of informatics (the ESPRIT programs) that had a tremendous impact on the strengthening of European research and on its capability to compete with US research. As we said in the beginning the book stops in the late Eighties. One reason for this choice is that at that time theoretical computer science had already become a mature science. The design of machines, operating systems, programming languages, database management systems, applications was, up to a certain extent, supported by theoretical studies and formal models and methods. A wide range of specialized conferences started in the late Eighties and early Nineties provided the outlet for the scientific work of thousands of researchers investigating all aspects of computing and of computing systems. The role of theory in computer science was, by now, well understood. The second reason is that the advent of the internet and of web based systems and applications at the beginning of the Nineties will dramatically change the landscape of computer science. A new phase and deep changes in the research agenda for theory of computing start at that point.

The book is supplemented with some documents that are useful to understand the atmosphere of those years (the most important is the twelve pages document 'Rapport préliminaire sur l'informatique théorique' prepared by Maurice Nivat and his colleagues at Paris VII in 1971) and with the program of some of the early conferences in theory of computing that may provide a view of the main subjects on which research efforts were concentrating.

Finally, in conclusion of this summary, I wish to thank again all the colleagues that have provided pictures, documents and personal memories. Besides, in particular, I wish to thank deeply my colleague Giorgio Gambosi for helping me in

revising and editing the book.