Priorities in Cybernetics, Computer Science and Artificial Intelligence About the beginnings of world and Romanian Informatics

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Abstract

Following studies and research within the ROINFO 2018-2020 project (Romanian Informatics) conclusions have been reached that must be known by the world scientific world. These conclusions refer to the emergence and development of Informatics in the world and in Romania. The role of some nations in the emergence and development of Informatics worldwide are highlighted,through the joint efforts of scientists - pioneers of Computing (Computer Science and Computer)s: mathematicians, physicists, engineers, cyberneticists, economists, psychologists, etc.From the conclusions of the ROINFO project, some facts unknown until today in the history of world informatics have been reached.For example, Romania can be proud of a "Romanian Informatics" because through the scientists from 1953-1970 it contributedto the development of researches regarding the construction of the modern computer, managing to build their own Romanian computers.Between 1953-1954, Romania ranks third in the world, after the USA and USSR, in the research activity on Theory of switching circuits - according to the number of articles (Grigore C. Moisil). Romania was the eighth country in the world designing and building an electronic computer (1957) and the 11th country in the world, which built an electronic computer with transistors. (1963). Therefore, comparing the scientific results and the contributions of scientists in the development of Informatics and computers,it can highlight the priorities of some researchers and scientists, worldwide or nationally. These priorities refer to Cybernetics - the science of systems, without which Informatics and the construction of computers would not have been possible.There is also evidence and results on some concepts and aspects regarding the vision of some scientists for the emergence and development of Artificial Intelligence - complex fieldfor building intelligent machines and systems that simulate intelligent human behavior in solving complex decision-making problems.

Keywords: Cybernetics, Computer Science, Artificial Intelligence, Informatics

MOTTO: "*All what is correct thinking is either mathematics or feasible to be transposed in a mathematical model*." Grigore C. Moisil(1906-1973)

"*The value of a scientific work is judged by the influence it exerts on the evolution of science. There are also clogged roads in science, rivers that instead of flowing into rivers and thus into seas and oceans, fail in a small lake or simply in a puddle*" Solomon Marcus (1925-2016)

1 Introduction

A science develops through the set of research, concepts, theories, methods and techniques that become valid and contribute to the study and solution of complex problems of science. Sometimes, over time, some of the theories, methods or techniques become obsolete and, through the appearance of more efficient and effective ones, disappear or are updated. Such examples are in mathematics, computer science, biology, medicineetc. The role of scientists is to contribute to these efforts to develop science. Globally, every nation has some fundamental contributions in the

development of a science, at various times when, scientists, researchers, engineers, etc. are inventors or have priorities in developing theories, methods or techniques. In this sense, Romania can also be proud of such people, even if in some situations the international recognition came later or maybe with great difficulties. Thus, a conclusive example is the case of Dr. *Ștefan Odobleja* (1902-1978), a forerunner of Generalized Cybernetics, who, only in 1978, at the Fourth Congress of the World Organization for General Systems and Cybernetics in Amsterdam, was recognized for its primacy (1938-1939) to the mathematician *Norbert Wiener* (1894-1964), who founded cybernetics (1948). For this reason, *Norbert Wiener* could no longer be awarded the Nobel Prize. The president of the congress, *J. Rose*, decided to award the gold medal "*Norbert Wiener*" - 30 years of cybernetics to *Nicolae Ceaușescu*, the leader of Romania.

About the beginnings and development of world and Romanian informatics

- **Year 1938**: *Inventive machine* - "Thanks to the psycho-physical reversibility, we can materialize the act of creation. Undoubtedly, the inventive machine has not yet been created, but we can see its creation soon." Dr. Ștefan Odobleja, "Consonant Psychology", Paris
- **Year 1973**: *Informatics* - "The Informatics/Computer Science restores not only the unity between the pure and the applied mathematical sciences, the concrete technique and the abstract mathematics, but also that between the natural sciences, the human being and the society. It restores the concepts of the abstract and the formal and makes peace between arts and science not only in the scientist' conscience, but in their philosophy as well.." acad. Grigore C. Moisil
- Year 2015: *Computational models*- „All important computational models came from simulating the activity of the nervous system. The automata models of the 1940s, the Turing machine of the 1930s, and the electronic computer produced by John von Neumann and his team in 1948 focused on the upper nervous system. In my 1964 book Finite grammars and automata there is a large chapter on the neural system, as modeled by finite automata and regular grammars by S.C. Kleene" acad. Solomon Marcus, 2015
- Year 2017: *Molecular computer* - "Define a molecular computer as one molecule which transforms, by random chemical reactions mediated by a collection of enzymes, into a predictable other molecule, such that the output molecule can be conceived as the result of a computation encoded in the initial molecule." PhD Marius Buliga

In 1978, as a student at the Faculty of Mathematics in Bucharest, Department of Informatics, I participated in the conference held by professors *Solomon Marcus*, *Cristian Calude*-fresh assistant and *Ionel Țevi*-researcher at the Institute of Mathematics with the topic "Gabriel Sudan - The first example of position recursive which is not primitive recursive ". The results of the research were published in *C. Calude, S. Marcus, I. Țevy*, The First Example of a Recursive Function which Is Not Primitive Recursive, Historia Mathematica, 6 (1979), pp. 380–384. Many years later, in 2017, I remembered this event-episode when writing an article in the ICVL 2017 volume: "*History of Informatics. From recursivity to the Turing universal machine and Horn clauses*", then in 2018 on the occasion of the elaboration of vol. I and II of "*History of Romanian informatics*"(ROINFO project 2018-2020). Prof. *Cristian Calude* - came from New Zealand, was present at the launch of vol. I and II, which took place in amph. S. Haret at the Faculty of Mathematics and Informatics, 26 sept. 2019. In the presentation made on this occasion, *C. Calude* referred to this episode and confirmed the aspects related to those researches from 1974-1978. Prof. *Sergiu Rudeanu* (1935-2019) also paid homage - http://mvlada.blogspot.com/2019/07/in-memoriam-prof-dr-sergiu-rudeanu.html, for his contribution to the development of programming pseudoboolean, which today underlies quantum computers. Solomon Marcus, in the book "*From Romanian mathematical thinking*", Scientific and Encyclopedic Publishing House, 1975, writes about these researches related to the recursive function *G. Sudan*.

2 The Pioneers in Computer Science/Informatics

David Hilbert, Wilhelm Acherman, Alonzo Church, Kurt Gödel, Alan Turing, John von Neumann, Norbert Wiener, Noam Chomsky

Fig. 1 The Pioneers in Computing (Computer Science /Informatics)

Worldwide, the American mathematician-of Hungarian origin, *John von Neumann* (1903 - 1957) is the author of the structure of the modern computer through "Von Neumann architecture", through the technical report "*First Draft of a Report on the EDVAC*" from 1945, architecture that was based on the work of the British mathematician *Alan Mathison Turing* (1912-1954), https://en.wikipedia.org/wiki/Alan_Turing- this was acknowledged by Neumann, who described the so-called abstract Turing machine) - "*On Computable Numbers, with an Application to the Entscheidungsproblem*", Proceedings of the London Mathematical Society, 2 42: 230–65, 1936. In 1943 Turing built-for the benefit of the British army, Colossus - the first digital electronic computer for decryption of German codes, and in the period 1945-1946 contributed to the prototype of the computer machine "*Automatic Computing Engine*", made physically later, in 1950. In 1946 Turing presented a work that represents The first detailed design of a computer with a stored program. Today, this architecture is recognized and valid.

The construction of the modern computer was preceded by research and scientific papers on the construction of a computing machine to perform calculations, but also operations with symbols. This is how the "*decision procedure*" (https://en.wikipedia.org/wiki/Decision_problem) arose from the computability theory and computational complexity theory. Decision problems usually arise in mathematical questions of decision-making, ie the problem of the existence of an effective method for determining the existence of an object or its membership in a set; some of the most important problems in mathematics are undecidable. The field of computational complexity classifies decision problems determined by how difficult they are to solve. "Difficult" in this sense

is described in terms of the computational resources required for the most efficient algorithm for a given problem. Meanwhile, the field of recursive theory classifies undecidable decision problems according to the degree of *Turing*, which is a measure of the non-computability inherent in any solution.

The origin of the decision problem dates back to the mathematician *Gottfried Leibniz*, who in the seventeenth century, after building a mechanical calculating machine, dreamed of building a machine that could manipulate symbols to determine the truth value of a statement. mathematical. He realized that the first step should be formal language, and much of his later work was directed toward that goal. In 1928, *David Hilbert* and *Wilhelm Ackermann* put the issue in the form presented above. Following his "program", Hilbert asked three questions at an international conference in 1928, the third of which became known as "*Hilbert's Entscheidungsproblem*". In 1929, *Moses Schönfinkel* published an article on the particular cases of the decision problem, which were prepared by *Paul Bernays*. Even in 1930, Hilbert believed that there were no unsolvable problems.

Lambda vs. the universal Turing machine and the LISP language

In 1936, *Alonzo Church* (1903–1995), https://en.wikipedia.org/wiki/Alonzo_Church and Alan Turing independently published papers showing that a general solution to the decision problem was impossible, assuming that the intuitive notion of " *actually calculable*"is captured by the functions that can be calculated by a *Turing machine* (or, equivalently, by those expressed in the lambda calculation). This hypothesis is now known as the *Church – Turing thesis* (https://en.wikipedia.org/wiki/Church%E2%80%93Turing_thesis). Alan Turing was extremely influential in the development of computer science, providing a formalization of the concepts of "*Algorithm*" and "*Computing*" by defining the *Turing machine*, which played an important role in the creation of modern computer. In 1930 he defined the concept of the universal machine that underlies the computer science revolution. In 1945 *Alan Turing* was a pioneer in the construction of an electronic computer, in parallel with the project of *John von Neumann* (EDVAC Report 1945). But Turing's real important role was in the scientific understanding of the workings of the human mind, which led to the famous "*Turing Test*" to define the intelligence of computing machines and predictions for the 21st century. The famous mathematician *Alan Turing* also made history, as today he is considered to be one of the forerunners of Computer Science and Artificial Intelligence. Worldwide, Turing's contribution to the development of various sciences and disciplines is recognized: mathematics, computer science, computer science, bioinformatics, computers and information technology, morphogenesis (morphogenesis, mathematical biology), artificial intelligence, philosophy and the rest of the scientific world. *Lambda calculus* (λ calculus) influenced the design of the LISP programming language (list processing) and functional programming languages in general. Church-type coding is named in his honor. In his honor, the Alonzo Church Award for Outstanding Contributions in Logic and Computing was established in 2015 by the Computing Machinery Special Interest Group for Logic and Computation (ACM SIGLOG), the European Association for Theoretical Computer Science (EATCS). Computer Science Logic (EACSL) and for the Kurt Gödel Society (KGS). The award is for a remarkable contribution in the field published in the last 25 years and has not yet received recognition through another important award, such as the Turing Award, the Paris Kanellakis Award or the Gödel Prize.

Kurt Gödel, David Hilbert, the development of mathematical logic and PROLOG language

Kurt Friedrich Gödel 1906-1978) - https://en.wikipedia.org/wiki/Kurt_G%C3%B6del, https://plato.stanford.edu/entries/goedel/, was one of the main founders of the modern era , metamathematics, in mathematical logic. He is known for his incompleteness theorems, which are among the landmark theorems in twentieth-century mathematics, and his research has touched on every area of mathematical logic. Based on his doctoral dissertation "*On the Completeness of the Calculus of Logic*" (1929), Gödel published the two theorems of incompleteness in 1931, when he was 25 years old, one year after completion of his doctorate at the University of Vienna. The first theorem of incompleteness states that for any self-consistent recursive axiomatic system strong enough to describe the arithmetic of natural numbers (eg, Peano arithmetic), there are true sentences about natural numbers that cannot be proved from axioms. To prove this theorem, Gödel developed a technique, now known as Gödel numbers, which encodes formal expressions as natural numbers. He also made important contributions to proof theory by clarifying the connections between classical logic, intuitionistic logic and modal logic. Participating in a lecture by *David Hilbert* in Bologna on the completeness and coherence of mathematical systems could have established the course of Gödel's life. In 1928, David Hilbert and Wilhelm Ackermann published "*Grundzüge der teoretischen Logik*" (Principles of Mathematical Logic), an introduction to first-order logic in which the question of completeness was posed: the axioms of a formal system are sufficient to result in any statement that is it true in all system models? This research in mathematical logic (propositional calculus theory and predicate calculus) led to the development of automated theorem proving theory, and to the design and implementation of the PROLOG (artificial intelligence) logic programming language, being the first language written on the basis of first-order logic.

The automatic proof theorem was pioneered in the 1960s by *Davis* and *Putnam* in propositional calculus. He also used *Herbrand's theorem* as a fundamental result of the mathematical logic obtained by *Jacques Herbrand* (1930). In essence, it allows a certain kind of reduction of first-order logic to propositional logic. Although Herbrand (1908-1930) initially proved his theorem for arbitrary first-order logic formulas, the simpler version presented, restricted to prenex formulas, which contain only existential quantifiers, became more popular. A complete automation (in the sense of a semi-decision procedure) of classical first-order logic was proposed in 1965 by *J.A. Robinson* (1930-2016) - https://en.wikipedia.org/wiki/John_Alan_Robinson, with a single rule uniform inference called resolution (unification / matching / matching procedures). Robinson's principle of resolution - inspired by the research of mathematicians Post and Herbrand (1930, 1930) is based on solving equations in free algebras (ie term structures), using the unification algorithm (J.A. Robinson, *A Machine-Oriented Logic Based on the Resolution Principle*, Journal of the ACM (JACM), January 1965, https://dl.acm.org/doi/10.1145/321250.321253). Many refinements of the resolution were studied in the 1970s, but few convincing implementations were made, except that the PROLOG language is, in a sense, conceived from this effort. Alan Robinson's major contribution is to the substantiation of the automatic proof theorem. Its unification algorithm eliminated a source of combinatorial explosion in the resolution procedure; it also prepared the ground for the logic programming paradigm, especially for the Prolog language. *J. A. Robinson* received the Herbrand Prize in 1996 for his distinguished contributions to automatic reasoning. Details: HANDBOOK OF AUTOMATED REASONIN, Edited by *Alan Robinson* and *Andrei Voronkov*, Elsevier Science Publishers B.V., 2001.

Norbert Wiener's Cybernetics (1894-1964) vs. Cybernetics of Ștefan Odobleja (1902-1978)

The mathematician *Norbert Wiener* - https://en.wikipedia.org/wiki/Norbert_Wiener is considered the founder of cybernetics, the basic principles being described in his work „*Cybernetics or Control and Communication in the Animal and the Machine*" (1948), even if 10 years previously the Romanian Dr. *Ștefan Odobleja*-military doctor, published in French the fundamental work in 2 volumes, "*Consonantal Psychology*" (1938-1939), in which he defined the bases of a new science, Cybernetics, which will propel the construction of the modern computer and developing a new science: Computer science. *Odobleja* established the fundamental ideas of Cybernetics - the 9 universal laws (http://mvlada.blogspot.com/2019/10/stefan-odobleja-precursor-al.html), the most important referring to feedback. *Norbert Wiener* is regarded as one of the first to theorize that all intelligent behavior was the result of feedback mechanisms, which could be simulated by machines and was an important early step towards the development of modern artificial intelligence. Wiener's name frequently appears in the context of computer development, where he made important contributions to solving differential equations (1940). His World War II preoccupation with directing artillery fire led Wiener to develop a communication and transmission system for cybernetics. Thus, the birth of cybernetics took place in 1943, and in 1947 Wiener reached an agreement with other scientists to use the term "cybernetics" - a Greek term (κυβερνήτης - helmsmen). It is a term that includes the regulation and linking of systems in the field of static mechanics, technology and systems in the world of living organisms.

Noam Chomsky's formal languages and grammars

Algorithms, cybernetic systems and formal languages. *Noam Chomsky* (b. 1928), https://en.wikipedia.org/wiki/Noam_Chomsky, known as the "father of modern linguistics" and the one who described the "*Chomsky hierarchy*" for grammars, developed the theory of transformational grammars.) through which he earned his doctorate in 1955, and in 1957 he appeared as a significant figure in linguistics with his landmark work "*Syntactic Structures*", which played a major role in reshaping language studies. He created or co-created the theory of universal grammar, generative grammar theory, the Chomsky hierarchy and the minimalist program. Based on descriptions based on grammar rules, Chomsky grouped natural languages into a series of four increasingly complex subsets and types, known as the "*Chomsky hierarchy*." This classification was and remains fundamental for the theory of formal languages and relevant for theoretical informatics, especially the theory of programming languages, the construction of compilers and the theory of automata. Today, there are over 700 programming languages according to some classifications: https://en.wikipedia.org/wiki/List_of_programming_languages, https://codelani.com/posts/how-many-programming-languages-are-there-in- t ....

3 The Pioneers in Romanian Informatics

Gabriel Sudan, Ștefan Odobleja, Grigore C. Moisil, Tiberiu Popoviciu, Victor Toma, Wilhelm Löwenfeld, Iosif Kaufmann, Solomon Marcus, Sergiu Rudeanu

Romania can be proud of the contribution of Romanian scientists - mathematicians and engineers, in several fields of scientific research, on the fundamentals of calculability theory, the fundamentals of cybernetics, algebraic theory of automatic mechanisms, mathematical logic applied to building and using the first electronic computers in Romania. A key role was played by acad. *Grigore C. Moisil* (1906-1973), considered the founder of Romanian computer science, together with the engineers who built and developed the Romanian computer industry.

Fig. 2 The Pioneers in Romanian Informatics

Also, today, it is known that the new science Cybernetics was born in Romania, in 1938 and 1939, when Dr. *Ştefan Odobleja*-military doctor, published in French the fundamental work in 2 volumes, "Consonantal Psychology". He defined the foundations of a new science, Cybernetics, which will propel the construction of the modern computer and the development of a new science: Computer Science, which will contribute to the development of Artificial Intelligence. Odobleja established the fundamental ideas of Cybernetics (the 9 universal laws), the most important referring to feedback.

Romania in those years, before and after World War II, was connected to the scientific and technical activity on the emergence of new sciences: Cybernetics and Informatics, through the scientific efforts of the world community, to the construction of computer systems. In the '60s, Romania was considered among the first countries in the world (after the USA, England, USSR, Germany, France, Japan, Austria, Holland, Italy, Denmark) regarding research and efforts to build the electronic computer. The Romanian school of mathematics developed under the influence of Romanian mathematicians who defended their doctorates with prestigious mathematicians from France, Germany, Italy. For example, the mathematician *Gabriel Sudan* (1899-1977) published in 1927 (before *W. Ackermann*, 1928), the first non-primitive recursive function.

Gabriel Sudan (1899-1977) and the study of recursive functions

Gheorghe Păun reports in [1]: In April 1973, before leaving for Canada, *Moisil* told *Solomon Marcus* that *Sudan*, a student of *Hilbert* with *Ackermann* in the 1920s in Göttingen, 1925 - would have produced such an example. *Moisil* did not have time to give details, it is not clear what details he had, and in Canada he died, as a result of which, later reported in various places, Professor *Solomon Marcus*, a real detective operation was launched, in search, first of all, of the work. in which *Gabriel Sudan* had that example - of course, in a completely different context and with a different terminology than that of recursive functions, a field developed only in the 1930s. Ionel Ţevy, researcher at the Institute of Mathematics of the Romanian Academy. "*After a careful*

examination of all the articles and books of Prof. Sudan, Cristian Calude turns his attention to the article Sur le nombre transfini ω ^ ω [omega-la-omega], published in the Bulletin Mathématique de la Société Roumaine Gabriel Sudan des Sciences, vol .30, 1927, fasc. 1, pp. 11–30 "(S. Marcus, From Romanian mathematical thinking, Scientific and Encyclopedic Publishing House, Bucharest, 1975).

Gheorghe Păun [1]: The text of Gr. C. Moisil, about a completely remarkable Romanian contribution, from the 1960s, to quantum computing: for several years, quantum computers of a restrictive, non-universal type, capable of solving some problems, have been produced. which are reduced to pseudo-Boolean programming, a topic developed by professors Sergiu Rudeanu and Peter Hammer (then Ivănescu), in Bucharest, at a time when there was no talk of quantum computers (the first speculations appear in the 1970s). Says Moisil: "The place that the school in Bucharest has, in the foundation and development of pseudo-Boolean programming, is a pride of the Faculty of Mathematics and the Institute of Mathematics". (*Florin Gheorghe Filip*, Romanian Civilization (coord. *Victor Spinei*) - Science and information technology in Romania, Romanian Academy Publishing House Bucharest, 2018, pp. 119-121).

Cybernetics was born in Romania - Cybernetics of Stefan Odobleja (1902-1978)

"*I coveted my whole life for the comfort of big cities, but fate, more prudent than me, protected me from this danger. I can believe that the realization of this psychology with a pronounced character of cybernetics is also due to the fact that its author lived his life in the province, closer to nature. The training in nature and the permanent contact with nature and its realities put me in the optimal conditions to reflect on my thinking and at the same time they imprinted on me an independent, personal and realistic attitude*"Dr. Ștefan Odobleja.

Dr. Ștefan Odobleja - military doctor, was a great scientific personality too much wronged. Between 1938 and 1939, 10 years ago, as the American mathematician *Norbert Wiener* (1894 - 1964), considered the father of Cybernetics, published his fundamental work "*Cybernetics or Control and Communication in the Animal and the Machine*", Odobleja wrote in French fundamental work in 2 volumes, "*Consonantist Psychology*." It defined the foundations of a new science, Cybernetics, which will propel the construction of the modern computer and the development of a new science: Computer Science. In 1939, he himself sent 150 books to scientific personalities, universities and large libraries in Europe, America and Asia, only to come to mankind, World War II and, who else wanted to analyze a deeply scientific work, which He was talking about new concepts at the time.Today, it is known that in 1941, the American scientist SM Strong published in the journal "Psychologists cal abstracts "a review of" Consonantal Psychology "which, by the way, had been sent to the world's major libraries, including American universities, but generally had very few reviews and was virtually ignored for a long time. It is also known that Dr. *A. Rosenblueth*, *Kurt Levin*, psychologist, as well as the mathematician Norbert Wiener, reprofiled after 1938 in psychology and neurophysiology, had information about the "*Consonantal psychology*" of the Romanian scientist *Stefan Odobleja*. This work aroused their interest in consulting the original. The mathematician *Wiener* knew French very well, lecturing in France, and the neurophysiologist *Rosenblueth* had studied medicine in France. Odobleja did not give a practical application to his ideas. He just wanted to show how the human psyche works, by studying and understanding the processes that take place in the human body coordinated by the human brain and mind.

Odobleja managed to send about 20 copies to university and medical libraries around the world and 20 copies to a number of foreign specialists. To *William Seaman Bainbridge* - American general, who participated in the International Congress of Military Medicine in Bucharest, June 8-

12, 1939, Odobleja sent him five copies, and the American doctor assured him that he would place them in the most suitable places. *Ştefan Odobleja* continued his research, especially in the direction of elaborating a logic from which tens of thousands of pages remained in the manuscript stage. Since 1972, when he read Norbert Wiener's autobiography, *Ştefan Odobleja* devoted himself to demonstrating the idea that the origin of cybernetics is in psychology and that "*Cybernetics was born in Romania in 1938*" through his work "*Consonantist Psychology*". In this sense, in order to mark his partnership, he published a special work, which appeared in the very year of his death, 1978: "*Consonantal Psychology and Cybernetics*", with a substantial preface by *Mihai Golu*.

It is also to be noticed that the author himself – *Ştefan Odobleja* – has diffused the prospect by which he announced the participants at the International of Military Medicine about the appearance of this paper "*Psychologie consonantiste*". That Congress took place at Bucharest between 8- June, 12th, 1937. At this Congress also participated a delegation of the Military Navy of USA, lead by Dr. *W.S. Bainbridge* who invited Odobleja to visit USA. In 1966 he moves back to Turnu Severin where he finds Norbert Wiener's book "*Cybernetics*" and becomes intrigued with the similarities to his own "*Psychologie consonantiste*". From this moment Odobleja started to wonder who had the priority of discovering cybernetics, given that Wiener's book had been published in 1948 ten years later after his and was translated in Romania, in 1966, two years after the authors death. Consequently, Odobleja launched some pertinent arguments about the way his rough manuscript could have got in the hands of Wiener. In 1938 he had send 5 copies to Dr. W.S. Bainbridge, who met Wiener when the USA Military Navy ordered the Technological Institute in Massachusetts, where Wiener was a member, to build devices for the anti-air raid cannons from battle ships. Beginning with 1972, when he read Norbert Wiener's autobiography, Ştefan Odobleja devoted his time to prove that the origin of cybernetics is in psychology. He published a special creation named "The consonantist psychology and cybernetics". He died on the September, 4th, 1978 in misery (Source: http://www.bdmsoft.com/ieeecontest/life.php).

Grigore C. Moisil (1906-1978) - the founder of Romanian informatics and the algebraic theory of automatic mechanisms

Grigore C. Moisil receives - post-mortem, in 1996, *Computer Pioneer Award* (Computer Pioneer Award - IEEE Computer Society) - the only Romanian who received this medal "*For the development of polyvalent logical switching circuits, the Romanian School of Computing, and support of the first Romanian computers*." (Https://www.computer.org/profiles/grigore-moisil)

Between 1934-1942, at the University of Iaşi, the mathematician Grigore C. Moisil (1906-1973) dealt with "Logic and the theory of demonstration" and aiming to "*learn mathematics from the beginning*", he studied at the "*wonderful library*" of the Mathematical Seminar in Iaşi, the book by *Hilbert* and *Ackermann*, but also the 3 volumes Principia Mathematica by Russel and Whitehead. Moisil learned about Lukasiewicz's multi-valued logics in the spring of 1935, when *T. Kotarbinski*, a professor at the University of Warsaw, gave 3 public lectures and a short lecture at the Mathematical Seminar on Lukasiewicz's writing without parentheses.

Between 1953-1954, Romania ranked third in the world, after the USA and the USSR, in the research activity on Theory of switching circuits, activity coordinated by *Grigore C. Moisil*, at the Faculty of Mathematics in Bucharest and at the Institute of Mathematics - after no. of articles (Grigore C. Moisil, CCUB Activity, AMC magazine, Technical Publishing House, no. 13-14, 1970). About the beginning of Romanian informatics. Univ. 1959/1960, when at the Faculty of Mathematics and Physics - University of Bucharest, acad. Grigore C. Moisil founded the section "Computing Machines", which was followed by students in the last two years of study (at that time studies in mathematics lasted 5 years). Testimony acad. Solomon Marcus - In 2013, in amph. Spiru Haret from the Faculty of Mathematics and Informatics, at the anniversary meeting of the

1978 promotion - Informatics, acad. Solomon Marcus (1925-2016) made the observation that Informatics in Romania has its sources, earlier, in 1954, when the foundations of the "Computing Machines" section were laid, through the free course "*Algebraic Theory of Automatic Mechanisms*" held of acad. *Grigore C. Moisil*. He also mentioned that in 1956 Grigore C. Moisil became the chairman of the Automation Commission of the Romanian Academy, and later, in 1965, he became the chairman of the Cybernetics Commission of the Romanian Academy.

The role of the *Computing Center of the University of Bucharest* (CCUB). In 1962, *Grigore C. Moisil* established, at the Faculty of Mathematics, the Computing Center, with the status of Laboratory under the Department of Algebra led by Gr. C. Moisil, which will become the Computing Center of the University of Bucharest (CCUB), the first with this profile in the country and which will have an important role in the training of computer scientists in Romania). He contributed decisively to equipping CCUB with the IBM / 360/30 computer system, a computer on which many generations of computer scientists were trained, and on which written programs were executed to solve problems in many scientific, economic, administrative etc. fields.

The mathematician Tiberiu Popoviciu and the Romanian computer DACCIC

Tiberiu Popoviciu (1906-1975), a visionary scientist, was a personality with important achievements in founding computer science in Romania in the '50s, both in terms of hardware and software. Notably, *Tiberiu Popoviciu* is the author of the first monograph in Romania on numerical analysis and approximation theory, 1937. We briefly list the following steps / arguments on the contribution of acad. T. Popoviciu at the founding of Romanian informatics ("Tiberiu Popoviciu" Institute of Computing Cluj-Napoca, Romanian Academy, https: //ictp.acad.ro/ro/tiberiu-popoviciu-unul-din-fondatorii-informatic ...):

- T. Popoviciu founded, in 1951, the Institute of Computing, within the Romanian Academy, its purpose extending in 1957 from mathematical research to the construction of electronic computers. Popoviciu's vision was to incorporate three valences of the notion of calculation. A first computer (MARICA, 1959), with electromagnetic relays, is made in just two years, being an experimental one. Currently, the Computing Institute is named after the visionary scientist who founded it (ICTP - Tiberiu Popoviciu Computing Institute).
- In 1958, on the initiative of acad. T. Popoviciu, the first *National Cybernetics Conference* in Romania is organized at the Institute of Computing. It is well known that, after the installation of communism in Romania, Cybernetics was defined as "reactionary pseudo-science invented by the bourgeoisie to divert the attention of the proletariat from the class struggle." How was this definition abandoned in Romania and how did cybernetics become useful? It is difficult to answer accurately and documented. We can think that the communist states had to give up this attitude when, in order to keep up with the western countries, they decided to build electronic computers.
- In 1962, the Department of Computing Machines for students from years IV-V was established at the "Babeș-Bolyai" University of Cluj-Napoca, a department where he started teaching computer science.
- In 1963, the Institute of Computing completed the construction of the electronic computer DACCIC-1 - the first computer in the country with transistors and internal memory (ferrite).
- In 1968, the construction of DACCIC-200 was completed in Cluj, the first Romanian computer with operating system and compiler, the most powerful computer designed and built in Romania.

- In 1971, the first computer science high schools in the country were established, in Bucharest, Cluj, Timișoara and Iași. Sophists trained at ICTP, and then at ITC, write some of the first computer textbooks for high school, teaching in the first years in class.

Eng. Victor Toma (1922-2008), the pioneer of the construction of Romanian computers

Thanks to Eng. *Victor Toma* and under his direct guidance, a series of electronic computers were made on tubes starting with CIFA-1 (April 1957), CIFA-2 (1959), CIFA-3 (1960), CIFA-4 (1962). , and then on transistors CET-500 (1964) and CET-501 (1966). The CIFA-101 (1962) and CIFA-102 (1963) computers were also made in the section led by Victor Toma. In 1962, Professor Grigore Moisil also spoke in emotional words about Victor Toma: "*It is the undeniable merit of the leadership of the Institute of Atomic Physics to have understood the importance of building electronic computers and to have supported this issue*". It is a sign of special appreciation and recognition of the undeniable merits of the great Professor Horia Hulubei, the director of the I.F.A., who lovingly encouraged the initial search by saying, "*Let Thomas take care of his tins*". Testimony of V. Toma: "*The idea of a computer grew gradually, with the support of the Institute of Atomic Physics (IFA); it was nothing at once. Here's why: IFA needed digital technology to measure radioactivity in large units: betatron, reactor and other units. So, as a result, Professor Huluba, who was the director of the Institute of Atomic Physics, set up an electronics lab, because at that time no one was thinking about computers. We started there to produce measuring equipment for various IFA workshops, competitive equipment, in competition with what was produced abroad. The measuring devices I worked on at that time, with use in nuclear research, had an electronic counter with an accuracy of 10 microseconds and a frequency of up to 100Khz. Some were patented and awarded, being announced at that time by academic journals in Romania and the USSR. At the same time, the Electronics magazine appeared, a magazine that promoted the results of our research, constituting a strong impetus for us* ".

There were no analysts and programmers yet to identify the problems to be solved on the computer, programs had to be made. Gradually, mathematicians began to take programming courses through which they taught the beneficiaries to make their own programs, in the machine code. In the following year (1956) we were assigned three graduates from the Faculty of Mathematics: *Zamfirescu*, *Vaida* and *Moldovan*. This was the first wave of trainees, but others followed. After another two years, I put into operation the CIFA 3 computer that was made by V. Toma together with Mihaela Ionescu and others, now having a team of 10-12 very good people, who worked hard. The CIFA 3 computer was commissioned by the Dubna Nuclear Research Institute in Russia (USSR), a powerful institute but lacking a computing system. In fact, there was an order for two computers, CIFA 3 and CIFA 4 for the Institute in Dubna. But when the construction of the CIFA 3 computer was completed, the interest of the Dubna Institute for these computers with more modest performance no longer existed. Therefore, the CIFA 3 computer, after working in IFA for a year and a half, was (re) bought by the Computing Center of the Faculty of Mathematics in Bucharest, where the director was Professor Moisil, very concerned about the new technique. Within the Collaboration Agreement between the Romanian Academy and the Bulgarian Academy of Sciences, the Vitoșa computer was made in Bulgaria, between 1960-1962, according to the CIFA-3 model. CIFA 4 meant a further increase in reliability and operational safety and, implicitly, a broadening of the spectrum of use of this computer model.

Wilhelm Löwenfeld and Iosif Kaufmann, creators of the MECIPT computer in Timisoara

„*Wili Lowenfeld was without a doubt the soul of MECIPT (Electronic Computing Machine of the Timişoara Polytechnic Institute). We cannot deny the merits of Iosif Kaufmann as a brain of MECIPT, but without Wili the computer certainly would not have appeared. Out of an extraordinary vitality, with a perseverance that I always took as a model without success, Loewenfeld managed to coordinate the few resources that were for the completion of the project in a way that many project managers today could envy him. In 1961, as a fourth year student at the Faculty of Electrical Engineering in Timisoara, I was approached by Vili Lowenfeld, one of the two creators of MECIPT - a project that was already talked about, but not out loud. Vili brought me to the computer then before I was born and I started working with Iosif Kaufmann, in the form of a fashionable student circle at that time. It was the moment when, after the initial impulses of Grigore C. Moisil, I decided that I wanted to work in the field of computers at any cost*. " Prof. Dr. Ing. Vasile Baltac, http://evocari.blogspot.com/2008/07/wili-loewenfeld-primul-pionier-al.html

- Interns at MECIPT-1: "The MECIPT-1 computer was, in 1963, the only one in the entire network of higher education institutes in Romania. I think it was Professor Moisil's initiative that the practice of some of the students who finished the 4th year of the mathematics faculties be done on this computer. The practice was carried out, between 1963 and 1966 inclusive, in July, with about thirty students, led by a specialist from the Computer Center of the University of Bucharest. In the first year students came from Bucharest, Cluj and Iasi, in the following year from Bucharest and Cluj, then only from Bucharest. Students were given daily lessons, theoretical or practical, about MECIPT. These lessons were also attended by other people interested in programming. After presenting the principles of computer operation, made by the builders, in the last two weeks I talked to them about programming. At the end, there was a colloquium, to which, of course, no one fell, but which was not formal at all "(*Dan D. Farcaș*).
- Programs and calculations on the MECIPT-1 computer: "One winter, in the early' 60s, the dome of the central pavilion of the national exhibition (today "Romexpo", in the Free Press Square) flattened under the weight of the snow. The restoration of the dome (which has been resisting since then) was entrusted to a team from the Timisoara Polytechnic, under the leadership of academician Mateescu, and the related calculations were performed on MECIPT-1, the programmer being Vasile Baltac. Also here were elaborated, in detail, the plans according to which the concrete was poured in the dam from Vidraru. An article in the press of the time estimated that these calculations would have required, manually, 9 months, and on the computer they were completed in 18 days, including the transcription in final form of the tables, which could be sent directly to the site. Simulations were also made for a possible hydropower plant on the Danube, with the Bulgarians, in the Izlaz-Somovit area, the water network of Arad municipality was dimensioned, the resistance calculations were made for several tall buildings, etc. " (Dan *D. Farcaș*).

Solomon Marcus (1925-2916), the mathematician of frontier and interdisciplinarity

Academician Solomon Marcus, a renowned scientist with a solid international career, developed over 65 years, the Romanian mathematician and computer scientist whose name is quoted in major international encyclopedias, has published over 50 volumes and 400 articles scientific, in various fields: mathematical analysis, mathematical linguistics, theoretical informatics, mathematical poetics, semiotics, history and philosophy of science, mathematical models in the natural sciences, history and philosophy of science and in the socio-human sciences. Solomon Marcus was the author of several interdisciplinary studies and books on the use of mathematics in linguistics, theatrical analysis, natural and social sciences. He was a permanent

animator among students and specialists, for the promotion and dissemination of mathematics and computer science in the most different fields: literature, history, archeology, economics, music, cinematography, etc.

- "He is the only Romanian mathematician with the Erdös number equal to one. He has carried out his research activity in mathematical analysis, topology, theoretical informatics, linguistics, poetry, semiotics, history and philosophy of science and applications of mathematics to natural sciences or society. His book Finished Grammars and Automata of 1964 is one of the first in the world in formal language theory, the theoretical basis in the study of deprogramming languages. " Acad. Prof. Dr. *Marius Iosifescu* in response to the reception speech at the Romanian Academy, Thursday, March 27, 2008.
- "We miss Moisil - since March 2016, this year, we also miss his great friend and successor, Professor Solomon Marcus. Two classics of Romanian mathematics and culture, two large personalities, founders with vocation, school creators, two consciences, landmarks, models. Unrepeatable, but that's why it would be useful for us to try to imitate them. To be forgotten - as some of the texts in the book say and as they all prove - cannot be forgotten anyway ... ". Acad. *Gheorghe Păun*, Moisil 110, Tiparg Publishing House, Curtea de Argeş, 2016.
- „The intellectual meeting with professor Solomon Marcus took place at the seminar of the Mathematical Analysis course of professor Miron Nicolescu from years I and II (1952-1953). Our assistant enjoyed all the freedom of initiative. The course and the seminar dissociated themselves from the treatment of N. Luzin's books of analysis of the time, which insisted on insignificant calculations, books that were not even quoted to us as the fashion of the period would have required. There was a mathematical battle on the board. The seminar turns into a thriller, the problems posed meeting the characteristics of the genre, the suspense, the tension and the solution as a revelation. The teacher assumes something of the role of the character Harley Quin in Agatha Christie looking to develop in us the ability to solve. Those math hours and conversations can't be forgotten. I remembered them when I was a doctoral student in Moscow and I was walking, unknown to anyone, in a way of being or not being, in the deserted corridor, in front of the office of IG Petrovski, the then rector of the huge University of Moscow. State of Moscow MGU where I was preparing my doctoral thesis with Prof. Alexander Gennadyevich Kurosh (1908-1971) (Professor Marcus's field of research was related to Petrovsky's). Kurosh was an illustrious algebraist, in the tradition / line of those considered, foundations for Theoretical Informatics in Romania. So I had the exceptional chance of an early meeting with a great personality and chosen culture like Professor Marcus, with whom I still communicate today, on such diverse topics ". *Dragoş Vaida*, „Acad. Solomon Marcus at the age of 90 or about living the culture. " Libertas Mathematica, vol 35, no. 2, 2015.

The mathematician Sergiu Rudeanu (1930-2019) and the structures of discrete mathematics

Prof. Dr. *Dragoş Vaida*: Sergiu Rudeanu was a mathematician who fully deserved the international recognition and echo, from which you had something to learn, not how to make your life easy, but certainly how to make a solid, unitary, coherent work, to which you should forget with gratitude and later.

The emergence of the interest of some mathematicians for computer science coincides happily with the manifestation of the interest for Axiomatic Algebra. The 1960s find Sergiu Rudeanu educated about his mathematical identity. Moisil's article, Gr. C, The activity of the Computing

Center of the University of Bucharest, AMC 13-14 (1970), 9-20, reveals as a major achievement the appearance of two new fields in the scientific literature from us and abroad, namely mathematical linguistics, due to acad. Solomon Marcus and later the pseudo-boolean programming theory, thanks to professors Sergiu Rudeanu and L. Peter Hammer-Ivănescu and Egon Balas.

"A very valuable research in the field of linear programming (transport problem) has been developed at the Institute of Mathematics of the Academy. Researchers at the Institute of Mathematics, together with a young mathematician from the Czechoslovak Republic, who came to us for specialization studies in the theory of discrete automata, have created a new chapter in Mathematical Economics: The Theory of Pseudoboolean Programming. This theory uses logic algebra techniques to solve economics problems. In pseudo-Boolean programming, the unknowns have only the values 0 and 1 (corresponding to the ideas of false and true in logic), but the functions that intervene have some real values. Numerous papers have been published in this theory, synthesized in a volume published in English by the Springer publishing house (P. Ivănescu, S. Rudeanu, Boolean methods in operations research and related areas, 1967) " Grigore C. Moisil, 1970.

Cristian S. Calude and *Marian Gheorghe* (Fundamenta Informaticae, vol. 131/2014): Research activity of Sergiu Rudeanu in lattice theory, algebra of logics, universal and Boolean algebras (see pseudo-Boolean programming (a subject he has initiated with PLHammer), automata theory and graph theory is internationally well-known and appreciated. A very good lecturer, who devoted time and energy to write many textbooks Prof. Rudeanu was also an excellent supervisor.The Mathematics Genealogy Project, http://www.genealogy.math.ndsu.nodak.edu/id.php?id= 60012, lists his 12 PhD students (including well-known researchers as D. Simovici, A. Iorgulescu and S. Istrail) and 13 descendants. ".

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