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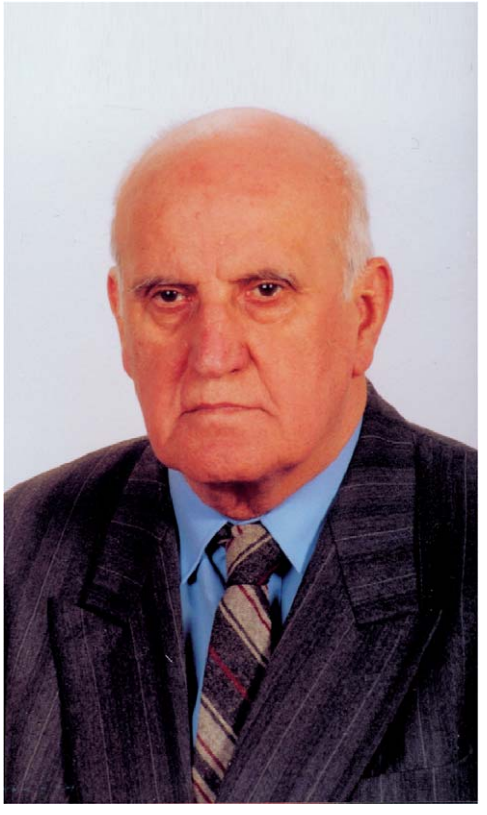
Obituary



Prof. Zdzisław Pawlak (1926–2006)

Professor Zdzisław Pawlak – our teacher and friend, the pioneer of computer science in Poland, an outstanding scholar who had an exceptionally valuable contribution to science, died in Warsaw on 7 April 2006.

The meaning of his contribution doubtlessly extends beyond contemporary insight, for Professor Pawlak's scientific work had a fundamental character and pointed out prospective directions of development in information processing research.

The most prominent achievement of Professor Pawlak was the formulation of rough set theory in the early eighties – a brilliant yet simple and general conception for reasoning from data. The implications of Professor Pawlak's theory are quite diverse, and though its baseline lies in computer science, today it is applied in various areas of science and technology, including philosophy, law, politics, and linguistics.

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Professor Pawlak arrived at formulation of his theory after years of productive work in the area of theoretical foundations of computer science. It is no exaggeration to say that Professor Pawlak's scientific career was a significant part of the 50-year-long history of Polish and international development in computer science.

He was born on 10 November 1926 in Łódź, where he graduated from a public elementary school in 1939. During the Nazi occupation he worked for the Siemens company. In 1946 he passed his Baccalaureate Diploma exam as an extern, and in 1947 he began studies at the Faculty of Electricity at the University of Technology in Łódź. Two years later he moved to the Faculty of Telecommunications at the Warsaw University of Technology. He received his M.Sc. degree in Telecommunications in 1951, after which he worked in the Institute of Mathematics of the Polish Academy of Sciences (PAS) until 1957.

His first scientific paper on random numbers generators, which appeared in 1953 in an American journal *Mathematical Tables and Other Aids to Computation*, was the first work of a Polish computer scientist published abroad. Since that time he had over 200 papers in widely available international journals.

From 1957 to 1959 he returned to Warsaw University of Technology, where he was active in constructing one of the first computing machines to be built in Poland, after which he returned to work at Institute of Mathematics of the PAS.

He received his Ph.D. degree from the Institute of Fundamental Technological Research of the PAS in 1958. His doctoral thesis concerned "The Applications of Graph Theory for the Synthesis of Decoders". Five years later he received his Habilitation in Mathematics, from the Institute of Mathematics of the PAS, based on his monograph "The organization of addressless machines".

From 1963 to 1969 he worked in the Institute of Mathematics at Warsaw University of Technology. Then he moved to the Institute of Computer Science of the PAS, where he held the position of Vice-Director for Research from 1971 to 1979.

He was made Professor in 1971, and Ordinary Professor in 1978. In 1983 he became a Corresponding Member of the Polish Academy of Sciences, and in 1991 a Full Member of the Academy.

From 1985 he worked at the Institute of Theoretical and Applied Computer Science of the PAS in Gliwice, and from 1998 at The Warsaw School of Information Technology. In 1989 he was also appointed the director of the Institute of Computer Science at Warsaw University of Technology, a position he held until 1996. He supervised 30 Ph.D. theses in computer science and mathematics.

Professor Pawlak was regularly invited as a visiting professor to universities in Europe, Asia, Canada, and USA, e.g. by the Department of Philosophy at Stanford University in 1965. He was a recipient of numerous awards, which include the State Award in Computer Science in 1973, the Knight's Cross and the Officer's Cross of the Order of Polonia Restituta, in 1984 and 1999, respectively, and the Hugo Steinhaus award for achievements in applied mathematics in 1989. In 2002 he was awarded an honorary doctorate by Poznan University of Technology.

He was a member of numerous scientific organizations and societies, including about 20 scientific boards, the Central Commission of Scientific Qualification (1975–1988 and 2000–2006), and the Committee for Scientific Research (1994–2000). He was the Deputy Editor-in-Chief of the *Bulletin of the Polish Academy of Sciences*, and served on the editorial boards of over several dozen other international and domestic journals. It was thanks to his initiative that the international journal *Fundamenta Informaticae* was founded.

The scientific biography of Professor Pawlak encompasses several essential periods. The first of them, in the late fifties, had to do with the construction of the first digital machine in Poland. During this period Professor Pawlak's interests focused on the organization and logic of digital computers.

In the sixties the major research in computer science focused on the aspects of computer logic and the theory of automata underwent a particular development. At that time Professor Pawlak concentrated on the organization of addressless machines controlled with a so-called transition function. He gave a new formal model of an addressless machine, different from Turing machine and Rabin-Scott automata, which attracted international attention and had been called "Pawlak machine" in the literature.

Professor Pawlak's research activities in the seventies centered on information retrieval systems. He proposed a formal model of an information system and a retrieval language, which made it possible to create a consistent theory of information retrieval systems and enabled a comprehensive analysis of such systems' efficiency.

At the same time Professor Pawlak became interested in formal DNA models. His formal model for Crick and Watson genetic codes was the first mathematic DNA model in the world.

The last period of Professor Pawlak's research activity, originated in the eighties, dealt with fundamental works on granular computing and rough set theory, proposed by him.

It was Paul Valéry who said that "a vague fact may be more perfidious than erroneous reasoning". Indeed, an error in reasoning may be found and corrected, but a vague fact cannot be corrected and, if it is mixed up with certain facts, it shall put everything in doubt . . . .

Therefore, vague facts need to be identified in knowledge about a given reality to be possibly used in approximate reasoning. Rejection of such facts is as bad as ignoring their vagueness, since vagueness may be symptomatic of a crucial aspect of the considered reality.

What is, then, the connection between the Valéry's statement and rough set theory? From set theory point of view, rough set theory is one of known escapes from "Cantor's paradise". It is based on the observation that knowledge about objects of a given universe is granular – objects described with the same information are indiscernible and form the so-called elementary sets, i.e. the granules of knowledge about the universe. If we want to express a concept concerning a given set of objects in the terms of knowledge about the universe, to which the objects belong, we generally encounter a situation that the considered concept cannot be precisely expressed using the available granules; in other words, the union of elementary sets having nonempty intersection with the given set of objects is not equal to the set. This given set or concept may be expressed approximately only, using a pair of classical sets called the lower and the upper approximation – the lower approximation is the union of all such elementary sets (granules) which are entirely included in the given set, the upper approximation is the union of all the granules which have a nonempty intersection with the given set. The difference between the upper and the lower approximation is called the boundary region, which consists of the vague objects, those impossible to resolve with certainty whether they belong or do not belong to the considered set. Distinguishing between the certain knowledge, represented by the lower approximation, and doubtful knowledge, represented by the boundary region, has a crucial impact on the reasoning process.

Rough set theory is complementary to fuzzy set theory and soft computing. Together they provide the best available today tools for analysis of data bearing some kind of "imperfectness", such as vagueness, ambiguity, imprecision, incompleteness, and uncertainty.

Since 1982, when the first paper on rough sets by Professor Pawlak appeared in *Journal of Information and Computer Science*, over 4000 papers on the subject have been published worldwide. This research deals with adaptation and extension of the theory to solve new scientific problems or various practical applications. The numerous papers prove the usefulness of rough set theory in answering fundamental questions coming from such fields as computing science, artificial intelligence, decision theory, theory of conflicts, machine learning, knowledge discovery and control.

The term *rough sets* has been included in lists of keywords of numerous scientific journals and conferences. The popularity of rough set theory resulted in the founding of *International Rough Set Society* as well as the journal *Transactions on Rough Sets*, published by Springer as a part of the Lecture Notes in Computer Science series.

Personally, I am grateful to Professor Pawlak for revealing me the concept of rough set at the beginning of its conception. Together with my brother Krzysztof, a surgeon, we had the privilege of working with him on the first real-world application of rough set theory – verification of indications for the treatment of duodenal ulcer by HSV. The cooperation with Professor Pawlak lasted until his health permitted and spread over my younger colleagues, particularly, Salvatore Greco. Professor Pawlak's kind personality made the cooperation really friendly and attracted further new disciples. It was also a pleasure to talk to him on subjects other than research – he was a connoisseur of photography and also a skilled landscape painter with an evident sensitivity for play of light and shadow.

In 1992 the first international seminar on rough set theory was organized in Kiekrz, near Poznan, by our Laboratory of Intelligent Decision Support Systems. This seminar originated a series of international conferences, called *Rough Sets and Current Trends in Computing* (RSCTC), which were held in Canada, USA, Japan, China, and Warsaw. We hoped to celebrate Professor Pawlak's 80th birthday during this year RSCTC conference in Kobe. God must have had a different plan . . . .

Despite his overwhelming scientific esteem, Professor Zdzisław Pawlak was a modest and considerate person. He radiated enthusiasm and kind encouragement for the young. We will keep a grateful memory of him alive.

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