

Studies in Fuzziness and Soft Computing

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Theory and Applications of Ordered Fuzzy Numbers

A Tribute to Professor Witold Kosiński

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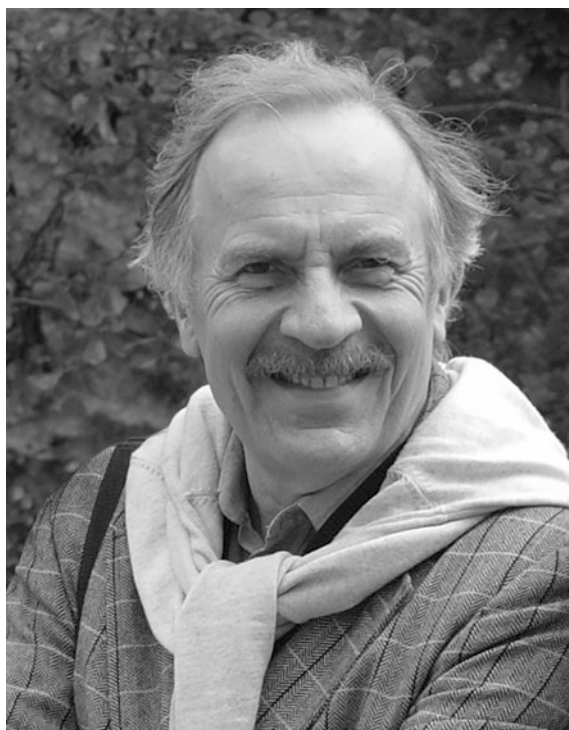
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Witold Kosiński (1946–2014)

Foreword

I met Witek Kosiński 20 years ago (almost to the day), as at that time he was appointed by the Institute of Computer Science, Polish Academy of Sciences, as a reviewer for my DSc (habilitation) thesis. His review was quite positive (!) and from that time we developed a long-lasting friendship. Later, both of us were associated with the Polish-Japanese Academy of Information Technology and together we supervised a few students, introduced new courses (e.g., puzzle-based learning), worked on several research grants, and wrote a few research papers. He, with his wife Ewa, visited us in the United States and stayed with us in our home; they also planned to visit us in Australia. Unfortunately, time had run out for him.

It is my privilege to write the foreword for this book. First, I consider Witek one of the best friends I had in life. Second, his warm personality, sense of humor, and amazing intelligence made him a very special person in the lives and careers of so many people. Finally, the book covers many topics that were close to Witek’s heart—fuzzy sets, fuzzy systems, Ordered Fuzzy Numbers—to name a few. He also had a keen interest in applications of his research, and thus the third part of the book contains 11 application-oriented chapters.

Witek—you’ll live in our memories forever. We miss you.

February 2017

Zbigniew Michalewicz

Memories of Professor Witold Kosiński

**Józef Kubik, Mariusz Kaczmarek, Marcin Sydow
and Dominik Ślęzak**

Professor Witold Kosiński, Polish mathematician and computer scientist, specialist in the fields of mathematical theory of continuous media and various methods of artificial intelligence with particular focus on fuzzy logic, conducted creative and very intense research activities for more than 40 years, combining research with broad international cooperation and regular teaching.

Scientific Development

Witold Kosiński was born in Kraków on August 13, 1946. He attended the Juliusz Slowacki High School in Warsaw in the years 1960–1964.

In 1969, he graduated from the University of Warsaw, the Faculty of Mathematics and Mechanics, obtaining his M.Sc. degree in mathematics for the thesis, “On the Existence of Two Variables Satisfying Some Differential Inequality.” His supervisor was Prof. Jan Rychlewski, later a member of the Polish Academy of Sciences.

Directly upon graduation he became a member of the Department of Mechanics of Continuous Media in the Institute of Fundamental Technological Research of the

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Polish Academy of Sciences, where he continued to develop his scientific qualifications by participation in doctoral studies.

In 1972, he obtained his Ph.D. degree in technical sciences with his dissertation, “Linear Theory of Rheological Materials with Internal Structural Changes.” His supervisor was Prof. Piotr Perzyna, a great scientist and author of one of the important directions within viscoelasticity theory. Very soon, Dr. Kosiński’s ability to combine mathematical methods with a modern approach to mechanics of deformable dissipative materials resulted in a number of achievements. In the years 1972–1974, he coauthored 19 research papers, 10 of which were published in the renowned *Bulletin of the Polish Academy of Sciences*.

In 1984 his research related to dissipative media led to the summarizing article on the equations of dissipative materials’ evolution resulting in the title of Doctor of Sciences (habilitation) in mechanical engineering being conferred upon him by the Scientific Council of the Institute of Fundamental Technological Research of the Polish Academy of Sciences. Finally, in 1993 his extensive research and teaching activities became the basis of granting him the title of full professor of technical sciences by the President of the Republic of Poland.

Scientific and Academic Achievements (Part I)

For most of his professional career Prof. Kosiński was affiliated with the Institute of Fundamental Technological Research of the Polish Academy of Sciences (1972–2001). In that period, he achieved numerous original results that contributed to international research on thermodynamics of materials with memory and materials with internal variables.

Those studies also concerned thermal waves in nonelastic media with so-called second sound effect, and were carried out jointly with other coauthors including, among others, V.A. Cimmelli, K. Frischmuth, K. Saxton, R. Saxton, W. Wojno, and P. Perzyna. Other studies on thermodynamics of porous media saturated with liquid were performed with the cooperation of K. Hutter, J. Kubik, M. Cieszko, and M. Kaczmarek. The monograph entitled *Clear-cut Nature of Initial and Boundary-value Solutions in the Theory of High and Low Non-elastic Strain in Scope of Hyperbolic Problems* (W. Kosiński, Ed., Ossolineum, 1979) aroused much interest. Particular recognition was gained by the monograph, *Field Singularities and Wave Analysis in Continuum Mechanics* (W. Kosiński, Ellis Horwood, *Mathematics and Applications*, 1986), which formulated the foundations of the kinematic theory of discontinuity surface propagation, the velocity of which depends on a nonlinear medium’s properties. The aforementioned range of Prof. Kosiński’s research on mechanics of continuous media includes over 100 published scientific papers, two monographs, and contributions to nine multiauthored volumes.

Scientific and Academic Achievements (Part II)

In 1999, Prof. Kosiński started his scientific and teaching activities at the Polish-Japanese Academy of Information Technology (PJAIT; formerly the Polish-Japanese Institute of Information Technology), where he served as a member of the Senate and Council of the IT faculty. In 1999–2005, he acted as the PJAIT vice-president for research. He was the head of the Multimedia and Artificial Intelligence Department, and then the Smart Systems Department and Research Center. He was also a coordinator of specializations in Intelligent Data Processing Systems, and Business and Administration Support Systems.

PJAIT-related activities came together with Prof. Kosiński's growing scientific interests in information technology and intelligent systems, with an emphasis on neural networks, image processing, fuzzy logic, and nature-inspired optimization algorithms. Those interests could be seen even earlier. In the 1990s, he coauthored some articles on fuzzy numbers and neuro-fuzzy systems, for example, "Fuzzy Numbers and Their Quotient Space with Algebraic Operations" (W. Kosiński, P. Słysz, *Bulletin of Polish Academy of Sciences: Mathematics*, 1993) and "General Mapping Approximation Problems Solving by Neural Networks and Fuzzy Inference Systems" (W. Kosiński, M. Weigl, *Systems Analysis Modelling Simulation*, 1998). Later on, his interests in fuzzy systems led towards developing a new fuzzy arithmetics model described in a number of papers, including "Ordered Fuzzy Numbers" (W. Kosiński, P. Prokopowicz, D. Ślęzak, *Bulletin of Polish Academy of Sciences: Mathematics*, 2003) and "Evolutionary Algorithm Determining Defuzzification Operators" (W. Kosiński, *Engineering Applications of AI*, 2007), and resulting in a number of applications reported in this book.

In summary, Prof. Kosiński's research interests were characterized by true interdisciplinarity, openness to new ideas, and the ability to utilize mathematics and artificial intelligence to model and solve real-world problems. In particular, in his work he combined a strong background in mechanics and materials engineering with a good understanding of information technology applications. In our opinion, this makes his scientific achievements unique and inspiring to others.

Scientific Collaboration

Professor Kosiński developed and maintained broad cooperation with people and scientific teams at foreign and domestic universities. He was awarded academic scholarships at the University of Iowa (the Division of Materials Engineering), the University of Bonn (the Institute of Applied Mathematics), the University of Heidelberg (the Institute of Mathematics), and the Darmstadt Technical University (the Institute of Mechanics). He was also a scholarship holder of the Alexander von Humboldt Foundation (1983–1985 and 1988).

Professor Kosiński was a visiting professor in the Laboratory Modeling in Mechanics at the University Pierre and Marie Curie in Paris (1989–1990), in the Department of Mathematics and Computer Science at Loyola University in New Orleans (1991), and in the Faculty of Science and Technology at the University Aix-Marseille III (1994–1995). In addition to France, Germany, and the United States, he visited universities in several other countries, including Italy and Japan. He also collaborated with research groups in Poland, at universities in Warsaw, Białystok, Bydgoszcz, and Toruń, sharing his broad knowledge, international experience, and, in particular, his kindness and passion for research.

Teaching and Supervision

Seminars and inspiring scientific discussions conducted by Prof. Kosiński resulted in a number of joint publications and guided young researchers towards modern interdisciplinary topics, those that combined the disciplines of computer science, biology, and industry. It is worth noting that he promoted 11 Ph.D. students, as well as 148 MSc's and engineers.

He liked and valued his teaching activities. He treated students with a true respect and in a friendly manner. For almost 20 years, he shared his knowledge with students of the Faculty of Mathematics, Physics and Technology at the Kazimierz Wielki University in Bydgoszcz (formerly the Academy of Bydgoszcz), with the major of “IT Engineering” that he coestablished. For over 15 years, he gave academic classes on various IT subjects at PJAIT, where he was one of the key people forming the teaching program on AI tools and applications.

Professor Kosiński also gave advanced lectures as part of graduate and post-graduate courses on the analysis of waves, constitutive modeling of nonelastic media, and thermodynamics of continua with superficial singularities, as well as on selected issues of mathematics, artificial intelligence, and information technology, in such units as: the Institute of Fundamental Technological Research of the Polish Academy of Sciences, the University of Warsaw, the Stefan Banach's Center, the University of Iowa, and the University of Rome “La Sapienza.” In the 1990s, he delivered a truly inspiring graduate course on neural networks at the Faculty of Mathematics, Informatics and Mechanics at the University of Warsaw, where he was able to put together various aspects of his background and experience to provide students with both advanced mathematical foundations and practical motivation for mastering the AI-based methodologies.

Scientific and Social Services

An important part of Prof. Kosiński's activities was his work on editorial boards of scientific journals such as *Archives of Mechanics*, *Engineering Transactions*, *Biblioteka Mechaniki Stosowanej* (in Polish), *Journal of Applied Mathematics and Computer Science*, and *Machine Graphics and Vision*. He was also the editor-in-chief of the international journal, *Mathematica Applicanda*, published by the Polish Mathematical Society.

Professor Kosiński was also very active as a member of a number of scientific societies including the Polish Society of Theoretical and Applied Mechanics, the Polish Mathematical Society, the Association for Image Processing, the Society of Interaction of Mathematics and Mechanics, the American Mathematical Society, and Societas Humboldtiana Polonorum.

He was also involved in important scientific projects of a social character. In particular, from 2012, he was a member of the Technical Subcommittee for Mathematics and Computer Science within the Scientific Committee for independent research on the causes of the Smoleńsk Catastrophe in 2010.

Personality and Memoires

In his everyday professional life, Prof. Kosiński was characterized by exceptional elegance, kindness, openness, an interest in the world, and a sense of humor. He led a busy social life and was the so-called "life and soul of the party." He actively practiced sports (e.g., tennis, diving) and was a keen dancer. Below there are several opinions of people who knew Witold Kosiński in person. This is how they remember him:

I met Prof. Witold Kosiński a dozen or so years ago. It was my privilege and honor to give lab classes to his lectures for 10 years. He liked people and was able to team up with them regardless of what they were doing. I used to discuss science with him in a train, in a car, restaurant, namely anywhere. Witold used to bring us to places and people he deemed worth it. Witold shall always be our spiritus movens, as we believe that, regardless where he is now, he still counts on us and counts with us.

Jacek Czerniak
Kazimierz Wielki University, Bydgoszcz, Poland

Witek Kosiński was an exceptional man, researcher, and above all, a friend—his warm personality and a sense of humor made him a very special man. We will miss him a lot!

Zbigniew Michalewicz
University of Adelaide, Adelaide, Australia

Professor Witold Kosiński's wide-ranging interests reached far beyond math and computer science. His scientific intuition unveiled not only basic application of the discussed issue, but also possible secondary applications, and directions for further research. He made us believe in ourselves and our ability to succeed as students, professionals, and scientists.

Dariusz Mikołajewski
Kazimierz Wielki University, Bydgoszcz, Poland

Any time I met Prof. Kosiński, I was deeply impressed by his innovative thinking, interesting and far-reaching ideas, and abilities to convey them in a highly convincing way. It is needless to say that he has made long-lasting contributions to the methodology of fuzzy sets and computing with fuzzy numbers.

Witold Pedrycz
University of Alberta, Edmonton, Canada

If you asked him for help, he always tried to find the solution which is best for you. He liked to discuss and was always open to good arguments. He understood that the discussions at the conferences are an important part of the scientist's activities.

Piotr Prokopowicz (Former Ph.D. student)
Kazimierz Wielki University, Bydgoszcz, Poland

Since we worked in the same institution, quite often we met briefly, exchanging a few words. These everyday conversations revealed the benevolent and sociable nature of Prof. Witold who gladly showed interest to others, offering his support and authority whenever it was needed. Prof. Kosiński was a man of very open mind and flexible research, an outstanding scientist but also the organizer, encouraging others to activity. He was extremely busy but at the same time constantly smiling and bursting with a sense of humor.

Bartłomiej Starosta (Former Ph.D. student)
Polish-Japanese Academy of Information Technology, Warsaw, Poland

I shall remember the Professor as a man who was always smiling, friendly and had an optimistic attitude towards the world. He was a man who could not imagine the proverbial "doing nothing." Once during my visit at the Polish-Japanese Academy of Information Technology he saw that I was sitting and doing nothing, so he quickly handed to me a copy of some lectures saying "Krzysztof! Please read it. One must not just sit doing nothing like that."

Krzysztof Tyburek (Former Ph.D. student)
Kazimierz Wielki University, Bydgoszcz, Poland

My Dad was an exceptional person. He was active in many fields, not only of scientific nature. He was interested in politics, sport, followed international news, and traveled a lot with Mum. I could talk with him about economics, methods of valuation, and corporate finance. He also liked spending free time actively, so I learned and practiced skiing with him, I took part in numerous canoeing weekends, and I played tennis. He had been learning throughout his entire life, despite all the academic titles which he held.

That's how I shall remember him.

W. Konrad Kosiński
Warsaw, Poland

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