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To Andrzej Skowron on His 70th Birthday

Preface

This very special, $2^{7.0} - 1$ volume of *Fundamenta Informaticae* is dedicated to *Andrzej Skowron* on the occasion of his 70th birthday. The contributions are on an invitational basis, but they have been reviewed according to the usual standards of the journal. The editors want to thank all the contributors and reviewers for their great work. Without it, this volume would be much less special.

It is very hard, if even possible, to describe Andrzej Skowron in a finite collection of words. He is such an unique personality and scientist. To get some understanding what he is like it may help to read the accounts included in this preface. These accounts are provided by persons who interact with Andrzej for years on both professional and personal grounds: Roman Świniarski with family, Janusz Kacprzyk, Damian Niwiński, and Stanisław Matwin.

When we started to circulate the idea of this special volume among Andrzej's extended scientific family, we have met an enthusiastic response. So enthusiastic in fact, that we were initially a little bit overwhelmed. Everybody wanted to be on board. We managed to convince several groups of researchers to join forces and write one comprehensive, yet compact article instead of several. In this way, it was possible to fit the material in one, thirty-six-piece volume.

The thirty-six articles that make this special volume of *Fundamenta Informaticae* span over a very wide range of topics. They reflect Andrzej Skowron's activities as a researcher and a scholar as well as his influence on a broad scientific community. In order to make this volume more approachable we have ordered the papers with respect to general areas their represent. To do that we have used a methodology that has quite bit to do with results of one of the research projects Andrzej was recently involved in. Namely, we have manually performed a semantic clustering of our contribution pool. As a result the papers have been organized into four disjoint clusters (thematic groups) that we briefly introduce below.

First of the clusters gathers articles that correspond to some fundamental directions in recent and past research of Andrzej Skowron. The reader will find in this cluster papers representing such areas as: foundations of rough sets, logical aspects of both rough and related models of computation, foundational issues relating to logical aspects of non-classical computational systems, formal and computational aspects of inference systems, and nature-inspired computational systems. In this cluster we have contributions by: Mihir K. Chakraborty and Mohua Banerjee; Anna Gomolińska and Marcin Wolski; Ewa Orłowska and Ivo Düntsch; Yiyu Yao; Lech Polkowski and Maria Semeniuk-Polkowska; Ludwik Czaja;

Grzegorz Rozenberg, Gheorghe Paun, and Mario J. Perez-Jimenez; Alberto Pettorossi, Fabio Fioravanti, Maurizio Proietti, and Valerio Senni; Andrzej Szałas and Patrick Doherty.

The second cluster contains papers that describe research results in topics associated with discovering, representing and making use of knowledge learned form data. In particular, several of approaches described in these papers make use of reducts and decision rules. The contributions made by Andrzej Skowron to methods and algorithms for representation, reduction, and simplification of information retrieved from data are instrumental here. There are also papers that deal with approximations and approximation spaces, an area pioneered by Andrzej. Members of this cluster are papers by: Mikhail Moshkov, Talha Amin, Igor Chikalov, and Beata Zielosko; Roman Słowiński, Salvatore Greco, and Izabela Szczęch; Jerzy Grzymała-Busse and Patrick G. Clark; Wojciech Ziarko and Xugunag Chen; Shusaku Tsumoto and Shoji Hirano; Zbigniew Raś and Hakim Touati; Hui Wang and Ivo Düntsch; Zbigniew Suraj and Krzysztof Pancerz; Jan Komorowski, Marcin Kruczyk, Nicholas Baltzer, Jakub Mieczkowski, Michał Dramiński, and Jacek Koronacki.

The third group of contributions relates to another large area of research on which Andrzej Skowron left his mark. The papers represent studies on fundamentals and applications of granular approach to knowledge-based systems as well as investigations into underlying notions of closeness, similarity, and nearness. They also address challenges associated with construction and usage of granular systems – in particular multi-layered, hierarchical ones – in knowledge discovery and decision support. Papers by the following authors make this group: Sankar K. Pal, Jayanta Kumar Pal, and Shubhra Sankar Ray; Marzena Kryszkiewicz; Bożena Kostek and Andrzej Kaczmarek; Alicja Wakulicz-Deja, Agnieszka Nowak-Brzezińska, and Małgorzata Przybyła-Kasperek; James Peters and Sheela Ramanna; Hung Son Nguyen, Sinh Hoa Nguyen, Tuan Trung Nguyen, and Marcin Szczuka; Guoyin Wang, Yuchao Liu, Deyi Li, and Wen He; Witold Pedrycz; Tsau Young Lin, Yong Liu, and Wenliang Huang.

The fourth and final group contains nine papers that represent a little wider range of topics. Among them are papers that deal with data processing in general, including research related to database technology as well as search techniques. There are papers in this cluster that deal with data and knowledge representation and navigation. There are also described various aspects of data mining including those that make use of multiagent approach as well as methods based on processing of visual information. In this cluster the reader will find contributions by: Jarosław Stepaniuk, Maciej Kopczyński, and Tomasz Grzes; Dominik Ślęzak, Piotr Synak, Arkadiusz Wojna, and Jakub Wróblewski; Henryk Rybiński and Jacek Lewandowski; Jiming Liu, Hao Lan Zhang, and Yanchun Zhang; Jan G. Bazan, Andrzej Jankowski, and Sylwia Buregwa-Czuma; Wojciech Froelich, Rafał Deja, and Grażyna Deja; Piotr Wasilewski and Adam Krasuski; Ning Zhong, Linchan Qin, Shengfu Lu, and Mi Li; Andrzej Czyżewski and Karol Lisowski.

The editors of this special volume would like to wish a Happy Birthday to Andrzej and hope that he will like this little gift.

Dominik Ślęzak
Hung Son Nguyen
October 2013 *Marcin Szczuka*

To a friend

My Dear Faithful Best Friend,

I am very happy I can add a few words to express my best wishes for you on such a wonderful occasion as your seventieth birthday.

I have always been and will be with you with all my heart, thoughts and warmest wishes from the bottom of my heart.

I wish you best health, family happiness and further great scientific achievements.

It is the moment when I can also show my gratitude for all the extraordinary proofs of your friendship, for your constant care and readiness to bring help to me and my family.

Thank you for remarkable scientific cooperation which has lasted continually for many years.

The words I'm writing now bring back nostalgic memories.

I often think back to our student time, many family celebrations we enjoyed together, to our countless friendly meetings usually concerning our extremely intensive scientific cooperation.

I remember, as if it was yesterday, our latest meetings: our Mazurian excursion with professor Pawlak, our autumn stroll in Banff and many more other situations, even chance encounters that always mattered a lot to me.

I still recall with my wife Halinka your visit in our house in San Diego and we are looking forward to your next visit.

I would also like to congratulate you on your great world-class scientific successes.

Once more I want to thank you for everything you have done for me and my family.

I wish you every success in the matters you are planning and the ones that you are dreaming of, concerning both you private life and the field of mathematics. Both me and my wife Halinka have been telling our students for years how much you contribute to the development of the world science.

I am proud of our friendship which has lasted over half a century. I am proud of such a long-standing cooperation with such a top-ranking scientist as you are, thanks to which we can together glorify our beloved Poland.

Yours

Roman Świniarski with wife Halinka and daughter Ania

My virtual and real encounters with Andrzej Skowron over more than two decades

For a long time, maybe even centuries, a widely observed tradition in the academic community, first in Europe and then world wide, was to publish some sort of a collection of articles, essays, etc. to express a deep appreciation to a scholar and researcher for his or her long time contribution to science and service to the academic community. Such a collection of works is usually a set of special contributions dedicated to that person written by his friends, peers, sometimes even opponents. This special issue, which constitutes such a kind of a deep appreciation, is dedicated to Professor Andrzej Skowron on his 70th anniversary.

Professor Skowron is a very special person in broadly perceived computer science not only because of his extraordinary publication record, very high number of citations and values of bibliographic indexes. These indicators do characterize the value and quality of research of a particular individual but they do not tell the whole story, credentials, merits, etc. about the individual, not to speak about human qualities. In short, though they measure the impact of a researcher and scholar, they cannot grasp the entire role of that person in science and life.

Professor Andrzej Skowron has been a very special person to our academic community. First of all, one should bear in mind that he has graduated with both a degree in engineering and mathematics. As strange as this may be, among great mathematicians, there have been quite many cases of such a career and a notable example is here Constantin Carathéodory.

Though Andrzej's professional career has been since the very beginning associated with mathematics, his engineering studies have certainly provided him with a deep conviction that constructiveness, usefulness for solving real world problems, and a clear relation to intuition should characterize even quite abstract contributions to mathematics. If one reads, for instance, memoirs of Stanisław Ulam, one can learn that his attitude has been very similar. Moreover, if I take my personal experience, one of my mentors, the late Professor Richard E. Bellman, one of the founders of dynamic programming and control theory. who is considered by many to be the greatest applied mathematician of all times, has been telling me the same during our frequent meeting in the early 1980s.

I have mentioned the above intentionally because we should be aware of the fact that such a constructive view of mathematics, and a clear vision that there is no, and has never been a conflict between "pure" mathematics and "useful" mathematics has resulted in an unprecedented increase of the role of mathematics and prestige of mathematicians in the 1940s and 1950s, and continuing until now. All those efforts have implied that to many people from a multitude of areas in science and technology it has become obvious that mathematics can provide extremely powerful tools for solving their real problems, without sacrificing intellectual depth and quality. Until today we have been witnessing that, to the benefit of all of us.

Professor Skowron's research record is very rich and, if we only take into account all kinds of bibliographic indexes, he belongs to a small group of the most prolific and productive Polish researchers and scholars in broadly perceived computer science. However, I wish to comment upon his contributions to rough sets theory only because of my personal interest and involvement.

Andrzej's interest in rough sets has emerged quite naturally as a next step in his long time attempts to develop tools and techniques that would make it possible to better represent problems faced by the humans and broadly perceived artificial intelligent systems with respect to data, information and knowl-

edge, to just use the famous Data-Information-Knowledge-Wisdom (DIKW) Pyramid (I deliberately omit here the last element, wisdom, for simplicity), as well as some crucial processes therein exemplified by reasoning and decision making. Andrzej's extremely valuable and significant contributions in this realm, notably on reasoning schemes under imprecise, missing and, more generally, imperfect information and knowledge have become milestones in the development of foundations of intelligent systems, in more theoretical direction.

To many people in modern computer science Professor Skowron is readily associated with rough sets theory. This is a very interesting aspect, and I think that I can say some words in this respect. First, as a person associated with fuzzy sets theory since the late 1970s, and since then a close disciple and collaborator of Professor Lotfi A. Zadeh, I have been able to witness the growth of that new, ingeniously simple and efficient, direction to the representation and handling of imperfect information and knowledge. Fuzzy logic has quickly grown to thousands of active researchers and scholars, a multitude of journals, books and edited volumes, congresses and conferences, etc. However, a real development has occurred after the so called fuzzy boom in Japan in the mid-1980s when the first real applications of fuzzy logic has been implemented in the control of subway trains, domestic appliances, car transmissions, camera autofocus, etc., and this is continuing until now.

One should however hear in mind that the foundation and launching of a new theory, in particular one that is departing so strongly from the existing paradigm (a partial membership of elements to a set other than the full one or not), is extremely difficult and practically impossible - no matter how brilliant the theory is - if not launched, or even supported, by some already famous people. Professor Lotfi A. Zadeh is such a person. What some people do not know, Zadeh was prior to the introduction of fuzzy logic already an extremely famous person in signal analysis, control theory, systems analysis, etc. What many people do not know, his state space approach - which culminated in the famous 1963 book with Desoer - is what virtually all people use in the modeling of all kinds of systems and processes. Moreover, as I was told by some Russian academicians, his early 1950s works on signal analyses with Ragazzini have been discussed at joint seminars of the two famous research institutes of the Academy of Sciences of the USSR, the Steklov Mathematical Institute and the Institute of Automation and Remote Control. This was extraordinary for engineering works. The greatness of Zadeh has been recognized many times, notably in 2010 when the IEEE Computer Society inducted Zadeh in their inaugural Hall of Fame in AI, together with Tim Berners-Lee, Noam Chomsky, Douglas Engelbart, Edward Feigenbaum, John McCarthy, Marvin Minsky, Nils J. Nilsson, Judea Pearl, and Raj Reddy. Notice that this recognition has been in spite of a generally negative attitude of the artificial intelligence community towards fuzzy logic.

I wrote the above to better show similar aspects related to rough sets theory, its founder Professor Zdzisław Pawlak, and a special role Andrzej Skowron has been playing. First, I must say that even in the early 1980 I did not know about rough sets, even if I was at that time very active in fuzzy sets. The situation started to change somehow in the mid- or late-1980s. Namely, after I spent several years in the early 1980s as a visiting professor in the USA, and then came back to Poland, I started to coming since ca. 1986 every two years to the USA as a visiting professor to teach a semester or so. At that time, while - if I remember well - at the University of North Carolina at Charlotte, Professor Zbigniew Raś organized in Charlotte a special workshop for Polish computer scientists and mathematicians because his mother, the late Professor Helena Rasiowa, visited the USA. At that time I had a chance to meet many well known people, mainly from the famous "Rasiowa school" who were staying in the USA. Andrzej Skowron was not with us but his name was mentioned many times by virtually all participants. This was my first acquaintance with Andrzej, unfortunately a virtual one only.

My second, also virtual, acquaintance with Andrzej, was also about that time when I was teaching together with Professor Pawlak at the Department of Computer Science, The University of Tennessee at Knoxville in 1986 or 1988. We had a chance to talk much about many things and Professor Pawlak showed me for the first time his rough sets theory which was totally new to me. I was amazed by the conceptual beauty, and simplicity and constructiveness of that theory. Professor Pawlak knew very well my close collaboration with Professor Zadeh, and also Zadeh himself, as well as a sheer power of fuzzy community that already in the late 1980s was in the thousands of people all over the world. During our numerous talks about both differences and common elements of both fuzzy sets and rough sets theories, and how to proceed to make rough sets theory a tool to be not only a "local hero", perhaps by using experience from fuzzy logic, a natural question was whether there is some initial group of people who would help develop and promote the new theory. Professor Pawlak told me that he was confident because he had some top people who got interested in the new theory. As one of them Andrzej Skowron was mentioned by him, and this was the second time I had a chance to virtually meet Andrzej.

The late Professor Zdzisław Pawlak was a very special person in many respects, and in our context I would mention the following. First, though his works had always been in broadly perceived theoretical (i.e. mathematical) computer science, he was a "real" engineer, always mentioning that he was not a mathematician but just working with mathematicians, while being an engineer. This was probably a reason that he had been able to easily find a common language with not only mathematicians, both pure and applied, but also with engineers, including myself. In my honest opinion, a long time and extremely fruitful collaboration between him and Andrzej is to some extent implied by their similar professional paths, ways of thinking and attitudes. As Professor Pawlak use to say, "to be an engineer sounds proud"...

On the other hand, I could clearly see a similarity between Professor Pawlak and Professor Zadeh, who were good friends. Namely, before the introduction of their new theories they have already been well known in their respective areas, with a long list of relevant publications and world wide contacts. I think that this fact had been decisive for the proliferation of rough sets theory too.

A notable event took place about in the turn of the centuries when we organized in the Systems Rasearch Institute, Polish Academy of Sciences in Warsaw, an interesting meeting of the three great ones - Professors Lotfi Zadeh, Zdzisław Pawlak and Roman Kulikowski, a famous control and systems scientist - who had been good friends since the early 1960s and met at the University of California at Berkeley at that time, having also an opportunity to meet Alfred Tarski. They talked about many aspects of science, and Zadeh was highly praising rough sets theory as one of relevant element of a large set of various tools and techniques to deal with uncertain, imprecise, missing, etc. information. I think that since that time Zadeh was always mentioning rough sets in his plenary talks.

Finally, in the mid-1990s I had a chance to meet Professor Andrzej Skowron in person, not only virtually. As all other people, I was immediately impressed by his deep knowledge and original thinking but also by his extraordinary human qualities. He was modest, friendly and - what is sometimes rare in a high ego type community like in the academia - always appreciative of results by other people, and listening to them.

At that time I was already the editor in chief of two book series at Springer, Studies in Fuzziness and Soft Computing and Studies in Computational Intelligence, which had soon become the largest in the scientific literature, and I was determined to include books and volumes on rough sets, notably by Polish authors and editors who had belonged since the very beginning to the pioneers and the best in that area. This happened soon and I was privileged to have, among other people, Andrzej Skowron as one of

the authors and editors of some relevant books, culminating in the recent big two volume book project dedicated to the memory of Professor Pawlak.

I will not describe in detail these book projects, as well as other numerous extremely influential works by Professor Skowron because other people are more qualified to do this. I will just mention one work that is, in my opinion, very relevant and to some extent characteristic for Andrzej's deep knowledge, original thinking and seeing "beyond the obvious" that is so important in science. Namely, some years ago he published, together with Professor Leszek Polkowski, also a prominent member of the Polish rough sets school, a very intriguing collection of works indicating a relation between Leśniewski's mereology and rough sets theory. To me, as well as many other people in the area all over the world, that work had played a multifaceted role as it recalled mereology that had been unknown to many people, it explained what mereology was all about which was not clear to many people who were even familiar with the term, and also showed some sort of a more universal power of rough sets. This is also a sign of Andrzej's greatness and vision.

One can further quote multiple seminal contributions of Professor Skowron but let me summarize them shortly. He is a great scientist and scholar whose works have shaped many areas, notably logic and rough sets, by providing not only technical and formal quality but a vision and a broader perspective which is extremely important in science, in particular in the present period when there is an intensive competition between not only people but the whole areas of science for funds, recognition, young researchers, etc. Andrzej is providing our area a clear advantage that can guarantee a further development. On the other hand, for rough sets, in its difficult period that always happens when the founder and driving force passes away, Andrzej is certainly one of the most prominent representative of the group of people, comprising notably some top Polish researchers and scholars, who are a guarantee of the survival and growth of the area.

Professor Andrzej Skowron, whose great scientific achievements I have tried to summarize above as they look from my personal perspective, is also a great human being. I would like to just briefly mention some aspects of that. First of all, an inherent obligation of all of us, older and more experienced researchers and scholars, is to intensively try to educate and promote a new generation of our followers. We have to give them very much, from just knowledge and expertise to ethical behavior. Andrzej is a great example of a real mentor in this respect. It is difficult to even list all young people who have grown up under his leadership, and have already reached a considerable stature in science. He has had a rare ability to discover and develop those talents, and provide them a generous help so much needed in the early stages of their careers. From a low level personal perspective, Andrzej has always been a loyal and trustworthy friend.

To summarize, this special issue dedicated to Professor Andrzej Skowron, a great researcher and scholar, educator, and a friend, for his anniversary, is just a small, but really small and by no means sufficient, token of appreciation by all of us. He certainly deserves this and much more.

Janusz Kacprzyk

From the Editor-in-Chief

It is my great honor to recommend this special issue to the readers of *Fundamenta Informaticae*, edited by Hung Son Nguyen, Marcin Szczuka, and Dominik Ślęzak, and dedicated to Andrzej Skowron for his 70^{th} birthday.

Andrzej Skowron served as editor-in-chief of this journal in 1994–2009, succeeding the late founding editor Helena Rasiowa. He took this role when the political transformations enabled free scientific exchange between Poland and the World. At the same time, the foundations of computer science were challenged by a new phase of the Information Age, marked by the Internet and ubiquity of computers. Inspired by the long-term vision of professor Rasiowa, Andrzej extended the journal in many dimensions. He included new fields of interest into *Fundamenta*'s scope, established connections with high-class conferences, and enlisted eminent scholars from all over the world to the editorial board. *Fundamenta Informaticae* has become a venue of presentation of original results in all areas of theoretical computer science. Once the journal had become visible worldwide, the number of submissions increased steadily, which was eventually reflected by the number of published issues. In the year 2007 alone, the journal published 194 papers by 360 authors from 32 countries, on over 3800 pages.

Throughout the years, Andrzej was running the journal with remarkable efficiency, mostly by e-mail, exchanging thousands of messages with authors, editors, referees. On top of this incredible work, Andrzej has become to his collaborators a true guide of what competence in science is. A learned expert in the existing theories and emerging trends, he has been continuously searching for more: understanding the problems that real world sets to science.

Many are those who owe their scientific development to Andrzej's guidance, inspiration, and encouragement. Like once professor Rasiowa, he was able to discover the growth potential of a student, colleague, or contributing author, and help these people to develop the best of their talent.

Let this special issue of *Fundamenta Informaticae* pay tribute to its meritorious editor.

Happy birthday, dear Andrzej!

Damian Niwiński

Andrzej Skowron – a mentor and a friend

Andrzej Skowron is a mentor and a friend. I consider him a model for the younger generation of Computer Scientists. He combines several exceptional achievements, which together make him a truly outstanding and unique contributor to science in general, and to Computer Science in particular.

Firstly, Andrzej has an exceptionally thorough background in both theoretical foundations of Computer Science and in its engineering aspects. It has to be remembered that he holds Masters' degrees in both Mathematics and in Electrical Engineering. This duality, representative of both foundational aspects of our field, is rare and very valuable for a Computer Scientist. The unusual breadth of his expertise is well represented in the list of his memberships in the Editorial Boards of international journals, which extend from Studia Logica through Theoretical Computer Science to Computational Intelligence and the KDD journal. Similarly, he has reviewed for an enormous spectrum of journals, from Bulletin of Polish Academy of Sciences to Neurocomputing to IEEE Transactions on Biomedical Engineering.

Secondly, Andrzej is an exceptional contributor to our discipline. His CV extends to almost 50 pages. His h-index is an astonishing 52, probably the highest for a Polish Computer Scientist, with several papers cited more than 1000 times. It is clear that his research and scholarly work has had and continues having a very significant impact globally. This has been recognized internationally with several prestigious awards and honours, such as the award for his contribution to the Association for Computing Machinery. He has written numerous papers in soft computing, in granular computing, in logical aspects of Computer Science, and in foundations of decision making. Andrzej has produced more than twenty Ph.D.s, who have gone on to their own impressive careers. Many of them have already produced their own Ph.D. graduates, making him a scientific grandfather.

Thirdly, anyone who has ever met Andrzej is thoroughly impressed with his generosity with his time. Andrzej is as far from selfish as possible. Always there to help younger scientists, to assist in a paper review or in organizing a conference, to write a reference or recommendation. Many of us, including myself, are indebted to him for the time and effort he put in working with us in his typical, self-effacing manner. And when called upon, Andrzej donates his time to our community in a variety of assignments and leadership positions, e.g. as the Vice-dean of the Faculty of Mathematics, Computer Science and Mechanics at Warsaw University, as the Vice-President of Scientific Council of the Institute of Computer Science of the Polish Academy of Sciences, or as the Head of the Senate in the Polish-Japanese Institute of Information Technology.

A scientist's calibre is correlated with the number of invitations for talks and presentations he receives from conferences and laboratories. Andrzej has literally gone around the world as an invited speaker, including the US, Canada, Japan, and China.

Andrzej's contributions are many, and extend a rich span of Computer Science and Artificial Intelligence. Let us look at just a few examples of his research output, extending now to more than 400 papers over 40 years.

Andrzej is, and has been for a number of years, an unquestionable leader of the rough set approach to soft computing - the idea of the late Zdzisław Pawlak, which Andrzej perfected, elaborated, and disseminated, so that it is today one of the two main approaches to the all-important problem of approximate knowledge representation and reasoning (besides Lofti Zadeh's fuzzy sets). His seminal paper "The Discernibility Matrices and Functions in Information Systems", with Cecylia Rauszer, is an excellent example of the quality of work Andrzej produces. The paper addresses, in a novel way, and from the rough set perspective, some of the fundamental Machine Learning problems. It discusses the basic ques-

tions related to relationships between the data and the problems whose solutions may be computed, or learned, from this data. It is an elegant, compact presentation, containing exactly the minimum of analytical formalization necessary to introduce interesting properties and to be able to prove them. Proposed algorithms are analyzed for their complexity, and care is taken to focus on computation with polynomial cost. Effort is being made to be clear and explanatory, and it is sad, in a way, that the running example on the political issues in the Middle East remains unchanged more than 20 years after the publication of the paper (certainly, Andrzej cannot be blamed for this!).

Andrzej has made, throughout the years, a strong effort to connect and communicate the fundamental rough sets concepts to the symbolic Machine Learning community. And so in the important paper "Rough sets and Boolean reasoning" by Pawlak and Skowron it is shown how reducts and discernability can address such typical Machine Learning tasks as attribute selection, value selection, discretization, attribute value clustering, etc.

His work on approximate reasoning also needs to be noted. With L. Polkowski, Andrzej has proposed a mereology-based model for approximate reasoning. It is impressive how erudite this work is, with informed connections to Dempster-Schaeffer approach, neural networks, Bayesian methods, belief networks, many-valued logics, etc. Moreover, it is not limited to a logical discussion, but embeds its results in a multi-agent system.

It is important to note that Andrzej is and a has always been interested in applications of his work (and the work of his students), from medical diagnosis to semantic searches of the internet. He believes that the fact that an approach or an algorithm is applied to help solve a real-life problem is an important criterion in validating this work.

Discussing its recommendation for Andrzej's ECCAI Fellow title, the Scientific Council of the Polish Artificial Intelligence Society has noted that not only has Andrzej Skowron an extremely impressive research record, but he is still very active in AI research, producing new ideas and mentoring the next generation of AI researchers not only in Poland, but around the world.

We are lucky to have Andrzej Skowron as a a scientist, colleague, a mentor, and a friend. We, the global computing and Artifical Intelligence community, are indebted to him. We want him to know how grateful we are for being with us for all those may years, and how we are looking forward to partake in his experience, wisdom, and personal warmth in many years to come.

Stanisław Matwin