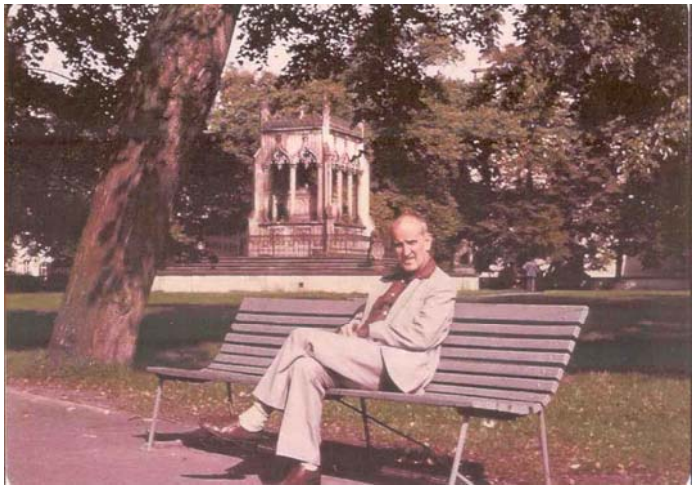
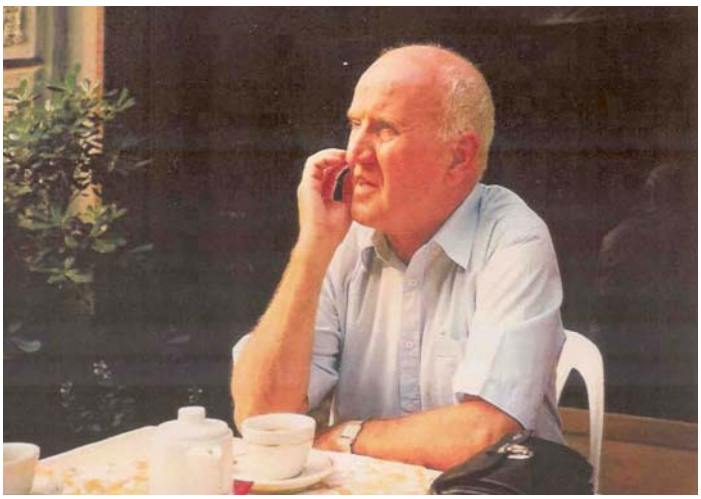
Zdzisław Pawlak
Life and work (1926 – 2006)

James Peters and Andrzej Skowron

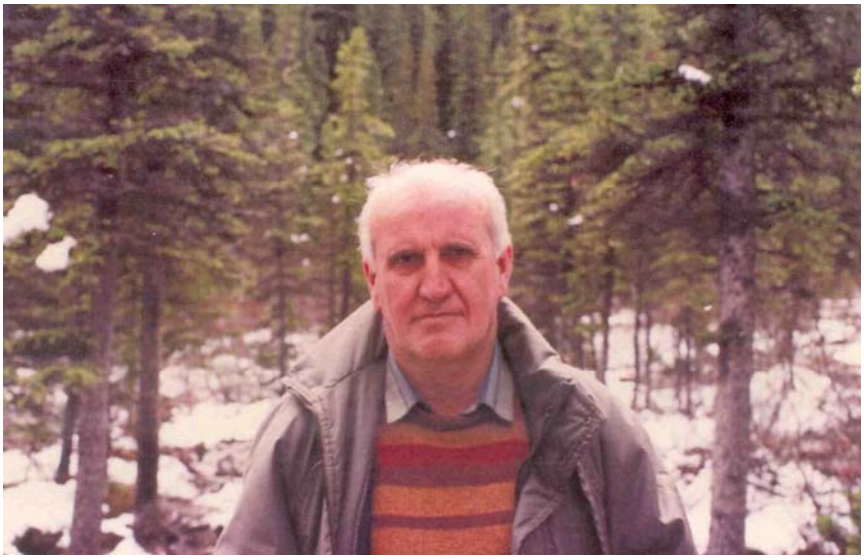
Professor Zdzisław Pawlak passed away on April 7, 2006 (1926 -2006)
Our great Teacher and Friend, Nestor and Pioneer of Polish Computer Science, Extraordinary Scientist who contributed so much to the World of Research



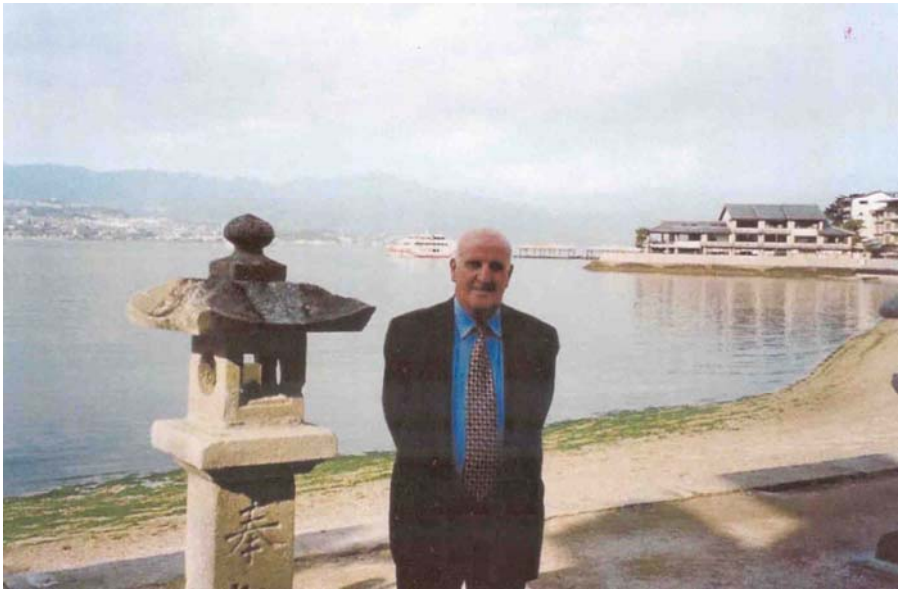
In the history of mankind, Professor Zdzisław Pawlak, Member of the Polish Academy of Sciences, will be remembered as a great human being with exceptional humility, wit and kindness as well as an extraordinarily innovative researcher with exceptional stature. His research contributions have had far reaching implications inasmuch as his works are fundamental in establishing new perspectives for scientific research in a wide spectrum of fields.



I was deeply saddened by the news that Professor Pawlak passed away. He was not just a great scientist - he was also a great human being. His passing away is a deep loss for his family, Poland, the worldwide community of researchers on rough sets and all those who knew him and worked with him. Please convey my profound condolences to his family and colleagues. With deepest sympathy and sadness. Sincerely, Lotfi Zadeh



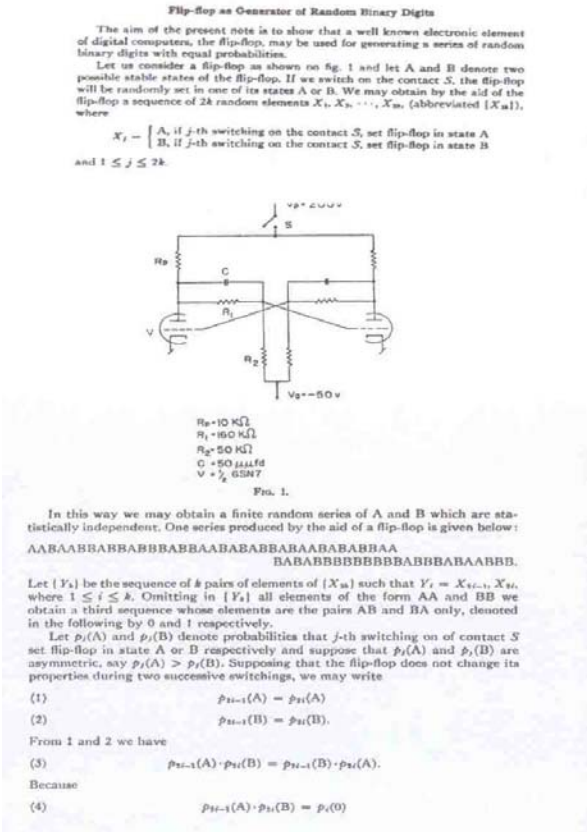
The road which led Professor Pawlak to his breakthrough findings was a long and successful one. Over more than fifty years Professor Pawlak conducted research in many emerging areas of Computer Science. Without an exaggeration we may say that his personal story of is one of most important threads in the 50 years history of Polish and World's Computer Science research. Roman Słowiński



Zdzisław Pawlak was born on 10 November 1926 in Lódź, 130 km south-west from Warsaw, Poland.

In 1947, Pawlak began his studies in the Faculty of Electrical Engineering at Lódź University of Technology, and in 1949 continued his studies in the Telecommunication Faculty at Warsaw University of Technology.

- In 1950, he presented in Poland the first project of a computercalled GAM 1.
- In 1939 he has finished his junior high school.
- The break of World War II interfered with his further education. During the azi occupation of Poland (1939-1945) he was forced to work for the Siemens company.
- He completed his M.Sc. in Telecommunication Engineering in 1951.
- After finishing study Zdzisław Pawlak started to work at the famous Institute of Mathematics of the Polish Academy of Sciences (PAS). He worked there until 1957.



Flip-flop as Generator of Random Binary Digits

The aim of the present note is to show that a well known electronic element of digital computers, the flip-flop, may be used for generating a series of random binary digits with equal probabilities.

Let us consider a flip-flop as shown on fig. 1 and let A and B denote two possible stable states of the flip-flop. If we switch on the contact S, the flip-flop will be randomly set in one of its states A or B. We may obtain by the aid of the flip-flop a sequence of $2k$ random elements $X_1, X_2, \cdots, X_{2k}$ (abbreviated $\{X_{2k}\}$), where

$$X_j = \begin{cases} \text{A, if } j\text{-th switching on the contact } S, \text{ set flip-flop in state A} \\ \text{B, if } j\text{-th switching on the contact } S, \text{ set flip-flop in state B} \end{cases}$$

and $1 \leq j \leq 2k$.

R_0=10 KΩ
R_1=150 KΩ
R_2=50 KΩ
C =50 μμfd
V = ½ 6SN7

FIG. 1.

In this way we may obtain a finite random series of A and B which are statistically independent. One series produced by the aid of a flip-flop is given below:

AABAABBABBABBBABBAABABABBABAABABABBAA
BABABBBBBBBBBBABBBABAABBB.

Let $\{Y_k\}$ be the sequence of k pairs of elements of $\{X_{2k}\}$ such that $Y_i = X_{2i-1}, X_{2i}$, where $1 \leq i \leq k$. Omitting in $\{Y_k\}$ all elements of the form AA and BB we obtain a third sequence whose elements are the pairs AB and BA only, denoted in the following by 0 and 1 respectively.

Let $p_j(\mathrm{A})$ and $p_j(\mathrm{B})$ denote probabilities that j-th switching on of contact S set flip-flop in state A or B respectively and suppose that $p_j(\mathrm{A})$ and $p_j(\mathrm{B})$ are asymmetric, say $p_j(\mathrm{A}) > p_j(\mathrm{B})$. Supposing that the flip-flop does not change its properties during two successive switchings, we may write

$$p_{2i-1}(\mathrm{A}) = p_{2i}(\mathrm{A}) \tag{1}$$

$$p_{2i-1}(\mathrm{B}) = p_{2i}(\mathrm{B}). \tag{2}$$

From 1 and 2 we have

$$p_{2i-1}(\mathrm{A}) \cdot p_{2i}(\mathrm{B}) = p_{2i-1}(\mathrm{B}) \cdot p_{2i}(\mathrm{A}). \tag{3}$$

Because

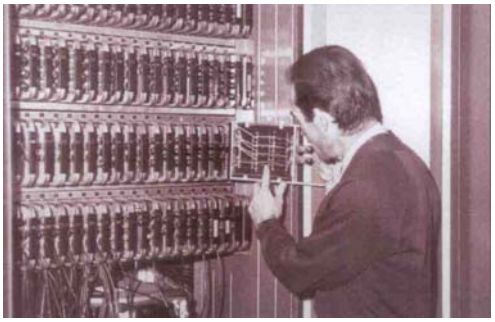
$$p_{2i-1}(\mathrm{A}) \cdot p_{2i}(\mathrm{B}) = p_i(0) \tag{4}$$

His publication *Flip-flop Generator of Random Binary Digits* in Mathematical Tables and Other Aids to Computation, Vol. 10, No. 53, Jan., 1956, 28-30on a new method for random number generation was the first publication abroad in informatics by a researcher from Poland.

In 1958, Pawlak completed his doctoral degree from the Institute of Fundamental Technological Research at the Polish Academy of Science with a Thesis on Applications of Graph Theory to Decoder Synthesis.

Between 1957 and 1959 Zdzisław Pawlak worked at the Warsaw University of Technology where he was one of the leaders in a project that led to building of one of first digital computing devices (now called computers) in Poland. After the end of this project he returned to Institute of Mathematics, PAS.

UMC1: 1961



The original arithmetic for the UMC1 computer system with base "-2" was due to Pawlak.

…During succeeding years, Pawlak worked at the Institute of Mathematics at Warsaw University and, in 1965, introduced the foundations for modeling DNA and what has come to be known as Molecular Computing.

Everybody associates his name with rough sets, but it is very little known that he is one of the pioneers of today molecular computing, by his chapter on genetics in his book in Polish "Grammar and Mathematics" published in the sixties. Solomon Marcus

He proposed a formal model for genetic code discovered by Crick and Watson. This model is by many regarded as the fist complete formal model of the DNA.

In this book there is a chapter 6 entitled "Genetic Grammars" in which Zdzisław Pawlak was aiming to develop an approach for grammars generating of more compound biological structures from simpler ones, e.g., proteins from amino acids. He proposed a generalization of traditional grammars used in formal language theory. For example, he is considering in this book a construction of mosaics on plane from some elementary mosaics by using some production rules of composition. In this chapter is also presented a language for linear representation of mosaic structures.

[Prof. Pawlak] proposed some mechanism operating concomitantly in two directions. On the one hand, in the direction of formal grammars, on the other hand, in the direction of what was called later picture grammars. Let us recall that both formal grammars and picture grammars were at that time at their very beginning. Formal grammars theory had to wait the year 1973 for a first satisfactory rigorous presentation (Salomaa1973), while picture grammars had to wait the year 1967 for a first systematic attempt (Shaw 1967) and two more years for the monograph by Rosenfeld (1969). Solomon Marcus

In 1963 he received his habilitation from Institute of Mathematics, PAS on the basis of monographic book „Organizacja maszyn bezadresowych" ("Construction of address-free machines").

Between 1963 and 1969 he also worked at the Institute of Mathematics, Warsaw University. Then he moved to newly created Institute of Computer Science of the Polish Academy of Science. Between 1971 and 1979 he was Deputy Director for Research at this Institute.

In 1983 Professor Pawlak became corresponding member of the Polish Academy of Science and 1991 he was awarded with full membership.

The topic of research:

- Computational models (1960s): models, now known in literature under the name of Pawlak Machines, significantly different from typical Turing Machines and Rabin-Scott automata.
- Information retrieval systems (1970s): foundations of a formal framework for studies on information retrieval systems, their efficiency and formal languages used in this process.
- Mathematical Linguistics (1970s)
- Mathematical Aspects of Production Organization (1970s)

The next research: **CONFLICT ANALYSIS.**

- Pawlak, Z.: On conflicts. International Journal of Man Machine Studies 21 (1984) 127-134.
- Pawlak, Z.: On Conflicts (in Polish), Polish Scientific Publishers, Warsaw (1987).
- Pawlak, Z.: Anatomy of conflict. Bulletin of the European Association for Theoretical Computer Science 50 (1993) 234-247.
- Pawlak, Z.: An inquiry into anatomy of conflicts. Journal of Information Sciences 109 (1998) 65-78.
- Pawlak, Z., Skowron, A.: Rudiments of rough sets. Information Sciences. An International Journal. Elsevier (20006) [to appear].

EXAMPLE

issues

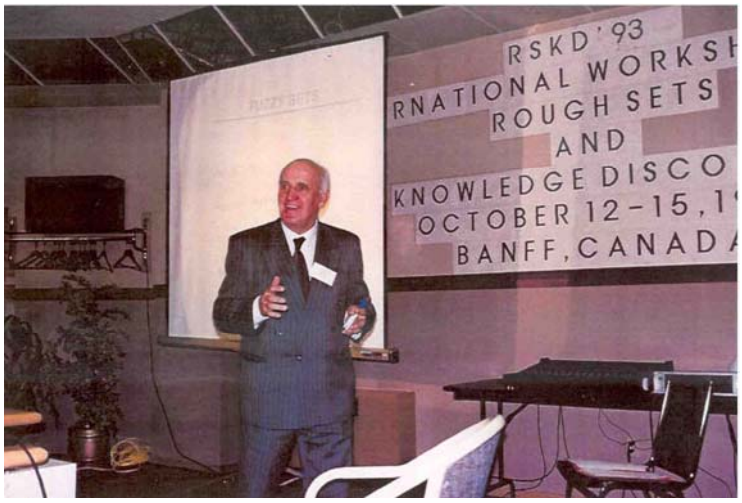
a - autonomous Palestinian state on the West Bank and Gaza
b - Israeli military outpost along the Jordan River
c - Israeli retains East Jerusalem
d - Israeli military outposts on the Golan Heightse
e - Arab countries grant citizenship to Palestinians who choose to remain within their border

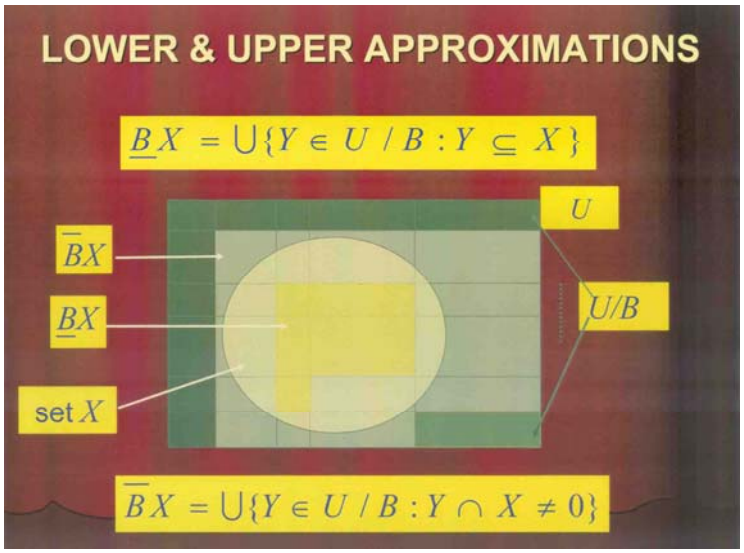
agents

1 - Israel
2 - Egypt
3 - Palestinians
4 - Jordan
5 - Syria
6 - Saudi Arabia

U	a	b	c	d	e
1	-	+	+	+	+
2	+	0	-	-	-
3	+	-	-	-	0
4	0	-	-	0	-
5	+	-	-	-	-
6	0	+	-	0	+

THE FUNDAMENTAL WORKS OF PROFESSOR PAWLAK ARE DEVOTED TO THE ROUGH SET THEORY.





INDISCERNIBILITY

IS = (U, A), $B \subseteq A$
Information about *x: $Inf_B(x) = \{(a,a()): a \in B\}$*
Two types of indiscernibility*:*
Equivalence:
xIND(B)y iff $Inf_B(x) = Inf_B(y$
Tolerance (similarity): τ
xIND(B)y iff $Inf_B(x)$ τ $Inf_B(y$

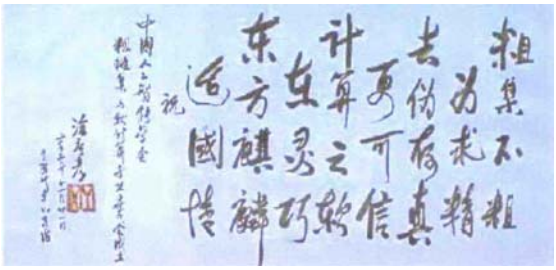
- Z. Pawlak, Rough Sets. Research Report PAS 431, Institute of Computer Science, Polish Academy of Sciences (1981).
- Z. Pawlak, Classification of Objects by Means of Attributes. Research Report PAS 429, Institute of Computer Science, Polish Academy of Sciences, ISSN 138-0648, January (1981).
- Z. Pawlak, Rough sets. International J. Comp. Inform. Science 11 (1982) 341-356.
- Z. Pawlak, Rough Sets - Theoretical Aspects of Reasoning about Data, Kluwer Academic Publishers, Dordrecht, 1991.

During the succeeding years, Professor Pawlak refined and amplified the foundations of rough sets and their applications and nurtured worldwide research in rough sets that has led to over 4000 publications. Rough Set Database System: http://rsds.wsiz.rzeszow.pl/.

Rough sets are not rough, and one moves towards precision. One removes the "unbelievable" so that what remains is more believable.

The soft part of computing is nimble. Rough sets imply a philosophy rooted in China.

Rough sets are not "rough" for the purpose of searching for accuracy. It is a more reliable and believable theory that avoids falsity and keeps the truth. The essence of soft computing is its flexibility. [Rough Sets] reflect the oriental philosophy and fit the Chinese style of thinking.
Xuyan Tu, Poet Yiyu Yao, Translator 21 December 2003.



RASIAKOWA – PAWLAK SCHOOL

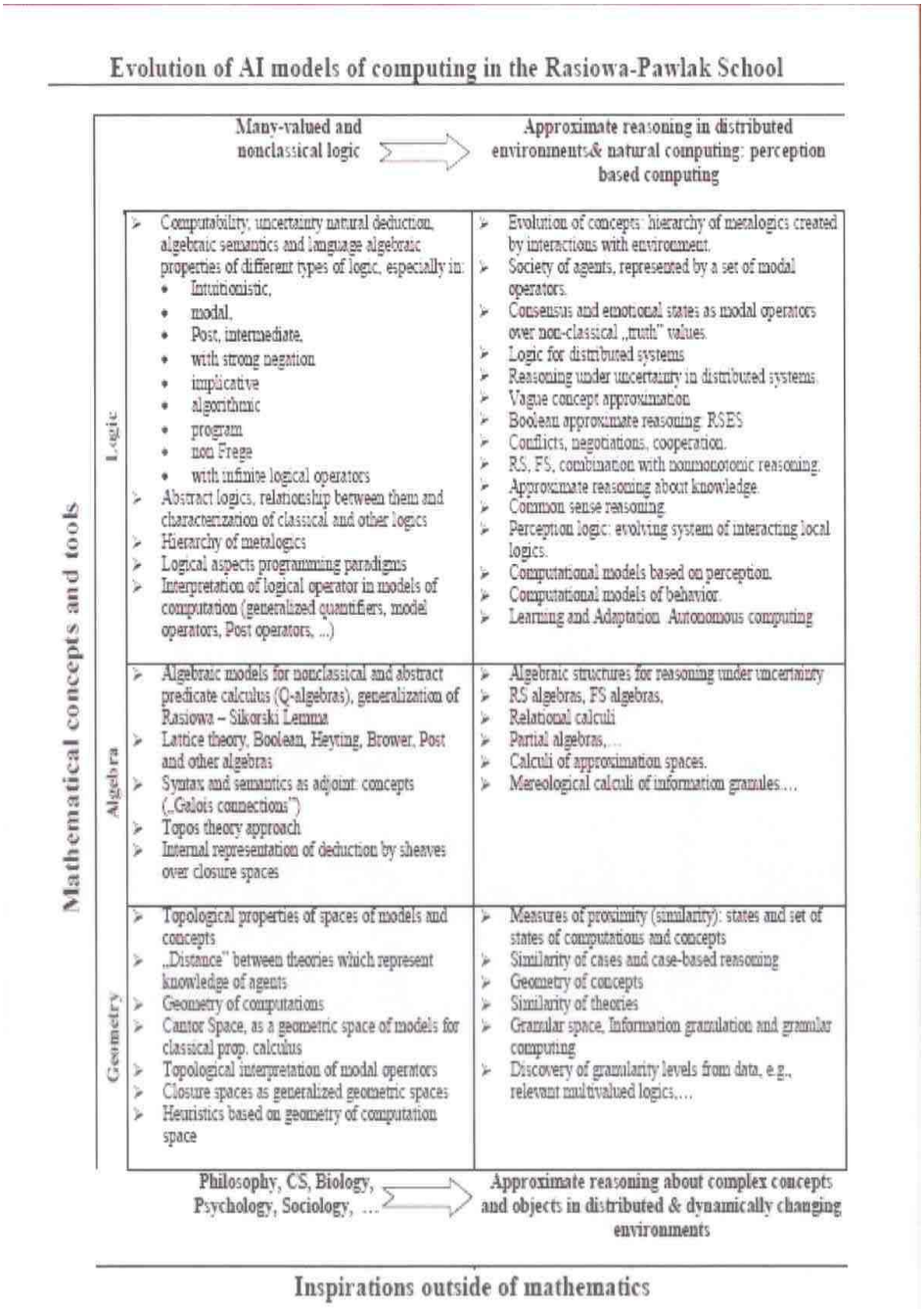
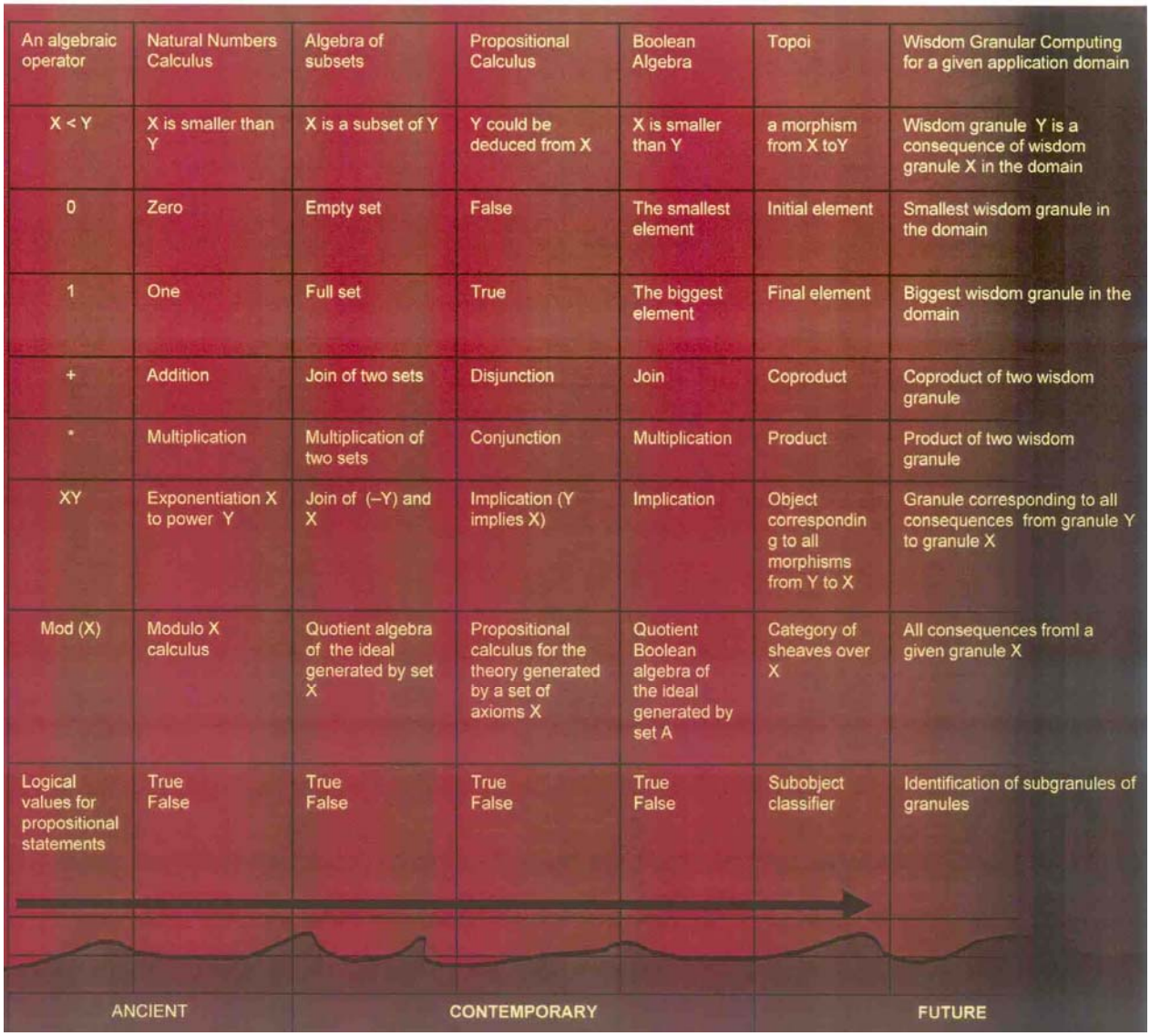


Fig. 10. Evolution of vague concept computation models from the Rasiowa - Pawlak School perspective



An algebraic operator	Natural Numbers Calculus	Algebra of subsets	Propositional Calculus	Boolean Algebra	Topoi	Wisdom Granular Computing for a given application domain
X < Y	X is smaller than Y	X is a subset of Y	Y could be deduced from X	X is smaller than Y	a morphism from X toY	Wisdom granule Y is a consequence of wisdom granule X in the domain
0	Zero	Empty set	False	The smallest element	Initial element	Smallest wisdom granule in the domain
1	One	Full set	True	The biggest element	Final element	Biggest wisdom granule in the domain
+	Addition	Join of two sets	Disjunction	Join	Coproduct	Coproduct of two wisdom granule
*	Multiplication	Multiplication of two sets	Conjunction	Multiplication	Product	Product of two wisdom granule
XY	Exponentiation X to power Y	Join of (–Y) and X	Implication (Y implies X)	Implication	Object correspondin g to all morphisms from Y to X	Granule corresponding to all consequences from granule Y to granule X
Mod (X)	Modulo X calculus	Quotient algebra of the ideal generated by set X	Propositional calculus for the theory generated by a set of axioms X	Quotient Boolean algebra of the ideal generated by set A	Category of sheaves over X	All consequences froml a given granule X
Logical values for propositional statements	True False	True False	True False	True False	Subobject classifier	Identification of subgranules of granules

ANCIENT CONTEMPORARY FUTURE

Affiliations:

Institute of Theoretical and Applied Computer Science, PAS in Gliwice, Poland (since1985),

Warsaw School of Information Technology from 1988,

Director of the Institute of computer Science at the Warsaw University of Technology (1989 and 1996).

Professor Pawlak was invited as a *Visiting Professor* to numerous universities in USA, Canada, Europe, and Asia, including an invitation to Philosophy Department of Stanford University in 1 965.

Professor Zdzisław Pawlak has received several awards in Poland and abroad.

1 - In 1973 achievements of his team has been recognized with National Award of Second Degree.
2 - For his distinguished service to the nation Professor Pawlak was awarded with Chivalry Cross (1984) and Officer's Cross (1999) of the Polonia Restituta Order.
3 - In 1989 he received the Hugo Steinhaus award for special achievements in applications of mathematics.
4 - Since 2002 he was a Honorary Doctor (Doctor Honoris Causa) of the Poznań University of Technology.

5 - Professor Pawlak was a member in many bodies and societies, including nearly 20 scientific boards in various institutions. He was a member of the Central Commission for Professional and Academic Titles and Degrees of Poland and a member of National Committee for Scientific Research (1994 - 2000).
6 - Zdzisław Pawlak was a member of editorial board of numerous Polish and International journals. Among others, he was Deputy Chief Editor of the Bulletin of Polish Academy of Sciences and one of creators of Fundamenta Informaticae Journal.

Zdzisław Pawlak gave generously of his time and energy to help others. His spirit and insights have influenced many researchers worldwide. During his life, he manifested an extraordinary talent for inspiring his students and colleagues as well as many others outside his immediate circle. For this reason, he was affectionately known to some of us as Papa Pawlak.

Profesor Pawlak had been given a lot of talents.
He was also a great painter and poet.

How near

How near to the bark of a tree are the drifting snowflakes,
swirling gently round, down from winter skies?
How near to the ground are icicles,
slowing forming on window ledges?
Sometimes snow-laden branches of some trees droop,
some near to the ground,
some from to-time-to-time swaying in the wind,
some nearly touching each other as the snow falls,
some with shapes resembling the limbs of ballet dancers,
some with rough edges shielded from snowfall and wind,
and then,
somehow,
spring up again in the morning sunshine.
How near to ...
- Z. Pawlak and J.F. Peters,
Spring, 2002.

Professor Pawlak, the father of rough sets, will always be remembered for his achievement and the contribution in the science of mankind…

Professor Pawlak contributed much for establishing friendship between Polish scientific community and Chinese scientific community. Guoyin Wang

Professor Zdzisław Pawlak was with us only for a short time and, yet, when we look back at his accomplishments, we realize how greatly he has influenced us with his generous spirit and creative work in many areas such as approximate reasoning, intelligent systems research, computing models, mathematics(especially, rough set theory), molecular computing, pattern recognition, philosophy, art, and poetry. As many can readily testify, Pawlak gave generously of his time and energy to help others. His spirit and insights have influenced many researchers worldwide. During his life, he manifested an extraordinary talent for inspiring his students and colleagues as well as many others outside his immediate circle.

James F. Peters and Andrzej Skowron