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Dedicated to Professor Emeritus Ioan A. Rus on the occasion of his 80^{th} anniversary

A glance into the beauty of Fixed Point Theory: Professor Emeritus Ioan A. Rus on his 80th anniversary

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ABSTRACT. Professor Emeritus Ioan A. Rus, a prominent and unfatiguable mathematician with an impressive oeuvre in the field of Nonlinear Analysis, particularly in Fixed Point Theory, will be 80 on 28th of August 2016. On this occasion, we would like to congratulate him and wish him good health, happiness, the same impressive physical and mental vigour, as well as new bright results in mathematics.

We also take this opportunity to present some information on the visibility and impact of Professor Rus' main scientific contributions, which would thus complement the information given in the following anniversary articles [Berinde, V. and Petruşel, A., *Professor Ioan A. Rus on his 70th birthday: a complete scientist, an accomplished mathematician*, Fixed Point Theory **7** (2006), No. 2, 167–174; Berinde, V. and Păcurar, M., *The joy of doing mathematics. Interview with Professor Ioan A. Rus*, Eur. Math. Soc. Newsl., **76** (2010), 47–50; Petruşel, A., *Professor Ioan A. Rus on his 75th birthday*, Fixed point theory and its applications, 33–38, Casa Cărţii de Ştiinţă, Cluj-Napoca, 2013].

Ioan A. Rus

1. INTRODUCTION

Both authors have unanimously admired Professor Emeritus Ioan A. Rus as early as they have met him during the undergraduate university studies, and then during the PhD studies completed under his supervision. However, Professor Rus continues to impress us

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by his fresh physical and mental vigour, by his joy and enthusiasm of doing mathematics, by the extraordinary energy and scientific curiosity he is showing to all of us today, like he did 10, 20, 30 or 40 years ago.

In support of this claim, we just mention the fact that, in the last five years (2011-2015), apart of numerous seminar lectures given to the weekly *Seminar on Nonlinear Operators and Differential Equations*, held at Department of Mathematics, "Babeş-Bolyai" University of Cluj-Napoca, he has also published 20 papers (according to *Zentralblatt MATH*), while in the last ten years (2006-2015) he has published 53 papers (according to *Zentralblatt MATH*). In *Zentralblatt MATH* database we find in total 190 publications by Ioan A. Rus indexed/reviewed there (as by 7th May 2016).

Now, if we search in the *MathScinet* database, we find a total of 187 publications of Ioan A. Rus indexed/reviewed there, with a total of 587 citations. In *MathScinet* we also find 62 reviewed papers for the period 2006-2015 and 24 reviewed papers for the period 2011-2015, all authored or co-authored by Professor Rus.

Really impressive!

Our main aim in this anniversary note is to present some data on the visibility and impact of Professor Rus' main scientific contributions. For detailed biographical information and scientific and didactical contributions, we refer the reader to the previous anniversary papers [1], [2], [3] and [4] and also up-date them with the fact that in 2015 Professor Rus has been elected as a Honorary Doctor (*Doctor Honoris Causa Scientarum*) of the West University of Timişoara, Romania.

2. Main scientific contributions

It is a really difficult task to select amongst the very diversified mathematical contributions of Professor Rus the few ones that would be the most significant, because, everywhere he tackled a research problem, he had some pearls of wisdom to offer to the mathematical research world. However, to restrict us to only two of his main contributions, we mention, according to [1]:

(1) *Picard and weakly Picard operators technique*;
(2) *Fixed Point Structure Theory*.

By using one of the reports *Zentralblatt MATH* database offers, we present the distribution of Professor Rus' main publications, according to **Mathematics Subject Classification (MSC 2010)**, which gives a better view on his various mathematics contributions. Note that the topic of a certain reviewed paper may fall into two, three or many different MSC 2010 subjects.

(1) 47-XX **Operator theory** (47H10 Fixed-point theorems for nonlinear operators on topological linear spaces; 47H09 Mappings defined by shrinking properties; 47H08 Measures of noncompactness and condensing mappings, K-set contractions, etc.; 47H04 Set-valued operators; 47J05 Equations involving nonlinear operators (general); 47J25 Iterative procedures (nonlinear operator equations) etc.): **107** reviewed papers;
(2) 54-XX **General topology** (54H25 Fixed-point and coincidence theorems in topological spaces): **93** reviewed papers;
(3) 45-XX **Integral equations** (45B05 Fredholm integral equations; 45G15 Systems of nonlinear integral equations; 45M10 Stability theory of integral equations): **28** reviewed papers;
(4) 34-XX **Ordinary differential equations (ODE)** (34B15 Nonlinear boundary value problems for ODE; 34A40 Differential inequalities (ODE); 34D20 Stability of ODE; 34D10 Stability perturbations of ODE): **22** reviewed papers;

(5) 35-XX **Partial differential equations (PDE)** (35B50 Maximum principles (PDE); 35J47 Second-order elliptic systems; 35K40 Systems of second-order parabolic equations, general): **17** reviewed papers;
(6) 41-XX **Approximation and expansions** (41A36 Approximation by positive operators; 41A05 Interpolation (approximations and expansions)): **9** reviewed papers;
(7) 39-XX **Difference and functional equations** (39A30 Stability theory (difference equations); 39B82 Stability, separation, extension, and related topics): **8** reviewed papers;
(8) 65-XX **Numerical analysis** (65F35 Matrix norms, conditioning, scaling (numerical linear algebra); 65J05 General theory of numerical methods in abstract spaces; 65J15 Equations with nonlinear operators (numerical methods); 65L99 Numerical methods for ODE; 65R20 Integral equations (numerical methods)): **7** reviewed papers;
(9) 00-XX **General mathematics** (00B15 Collections of articles of miscellaneous specific interest; 00B25 Proceedings of conferences of miscellaneous specific interest; 00B30 Festschriften): **5** reviewed papers;
(10) 26-XX **Real functions** (26A18 Iteration of functions of one real variable; 26D10 Inequalities involving derivatives, differential and integral operators; 26D15 Inequalities for sums, series and integrals of real functions): **4** reviewed papers;
(11) 37-XX **Dynamical systems and ergodic theory** (37B25 Lyapunov functions and stability; attractors, repellers; 37C25 Fixed points, periodic points, fixed-point index theory; 37C75 Stability theory; 37N30 Dynamical systems in numerical analysis): **4** reviewed papers;
(12) 40-XX **Sequences, series, summability** (40A05 Convergence and divergence of series and sequences; 40C05 Matrix methods in summability; 40G05 Cesàro, Euler, Nörlund and Hausdorff methods): **3** reviewed papers,...

Now, by using the corresponding reports extracted from *MathScinet* database, we have the following distribution of Professor Rus' publications (figures are not essentially different of the ones from *Zentralbaltt MATH*; we reordered items in the decreasing order of the number of reviewed papers in *MathScinet*):

(1) 47-XX **Operator theory**: **93** reviewed papers;
(2) 54-XX **General topology**: **91** reviewed papers;
(3) 34-XX **Ordinary differential equations (ODE)**: **26** reviewed papers;
(4) 35-XX **Partial differential equations (PDE)**: **17** reviewed papers;
(5) 45-XX **Integral equations**: **15** reviewed papers;
(6) 39-XX **Difference and functional equations**: **9** reviewed papers;
(7) 41-XX **Approximation and expansions**: **7** reviewed papers;
(8) 26-XX **Real functions**: **6** reviewed papers;
(9) 65-XX **Numerical analysis**: **4** reviewed papers;
(10) 37-XX **Dynamical systems and ergodic theory**: **3** reviewed papers;
(11) 00-XX **General mathematics**: **2** reviewed papers;
(12) 40-XX **Sequences, series, summability**: **2** reviewed papers,...

3. Quantitative impact and international visibility

An important factor in making one's research work in mathematics visible internationally is represented by the degree of spreading and accessibility of papers (journals) in the world. If we look to the journals where Professor Rus has published the most numerous of his research work along the years we find (from *Zentralbaltt MATH* database, again) the following figures:

(1) **Stud. Univ. Babeş-Bolyai, Math.** (39 articles);
(2) **Fixed Point Theory** (16 articles);
(3) **Prepr., Babeş-Bolyai Univ., Fac. Math. Phys., Res. Semin.** (9 articles each);
(4) **Math. Rev. Anal. Numér. Théor. Approximation, Math.; Prepr., Babeş-Bolyai Univ., Fac. Math., Res. Semin.**; ***Carpathian J. Math.***; **Prepr., Babeş-Bolyai Univ., Fac. Math., Res. Semin.; Theor. Comput. Sci.; Commun. Algebra** (7 articles each);
(5) **Stud. Univ. Babeş-Bolyai, Ser. Math.-Phys.** (6 articles each)
(6) **Acad. Repub. Popul. Romîne, Fil. Cluj, Inst. Calcul, Studii Cerc. Mat.; Math. Rev. Anal. Numér. Théor. Approximation, Anal. Numér. Théor. Approximation; Semin. Fixed Point Theory Cluj-Napoca; Sci. Math. Jpn.; Studia Univ. Babeş-Bolyai, Ser. Math.-mech.; Appl. Math. Comput.** (4 articles each)
(7) **Rev. Roum. Math. Pures Appl.; Comput. Mech.; J. Algebra; Babeş-Bolyai Univ., Fac. Math. Comput. Sci., Res. Semin., Prepr.; Bull. Math. Soc. Sci. Math. Roum., Nouv. Sér.; Mathematica, Cluj; Proc. Am. Math. Soc.; Nonlinear Anal., Theory Methods Appl., Ser. A, Theory Methods; Eng. Anal. Bound. Elem.** (3 articles each)
(8) **Int. J. Solids Struct.; J. Nonlinear Convex Anal.; Libertas Math.; Comun. Acad. Republ. Popul. Romîne; J. Lond. Math. Soc., II. Ser.; Glas. Mat., III. Ser.; An. Univ. Vest Timiş., Ser. Mat.-Inform.; Mathematica; *Creat. Math. Inform.*; Commentat. Math. Univ. Carol.; Manuscr. Math.; An. Ştiinţ. Univ. Al. I. Cuza Iaşi, N. Ser., Secţ. I-a; J. Comput. Phys.; Q. J. Math., Oxf. II. Ser.** (2 articles each),...

The scientific generosity of Professor Rus can be viewed from the number of his collaborators. Using the reports offered by *Zentralbaltt MATH* database, we can also find many of his former PhD students amongst his collaborators:

- *Petruşel, Adrian* (19 joint papers)
- *Şerban, Marcel Adrian* (10 joint papers)
- *Petruşel, Gabriela*; Lungu, Nicolaie; *Egri, Edith*; Rus, Bogdan (3 joint papers each)
- Mureşan, Anton S.; *Păcurar, Mădălina*; *Sîntămărian, Alina*; Agratini, Octavian; Trif, Damian; *Mureşan, Sorin*; Otrocol, Diana; *Berinde, Vasile* (2 joint papers each)
- Chiş-Novac, Adela; Iancu, Crăciun; *Mureşan, Viorica*; Precup, Radu; *Dârzu Ilea, Veronica Ana*; Yao, Jen-Chih; *Miklos, Edith*; *András, Szilárd*; Conţ, Ioan (1 joint paper each)

We would also like to show how rhythmic Professor Rus' publications have been, first according to *Zentralbaltt MATH* database: 2016 (1 paper reviewed); 2015 (1 paper reviewed); 2014 (6 papers reviewed); 2013 (4 papers reviewed); 2012 (5 papers reviewed); 2011 (2 papers reviewed); 2010 (10 papers reviewed); 2009 (6 papers reviewed); 2008 (8 papers reviewed); 2007 (7 papers reviewed); 2006 (6 papers reviewed); 2005 (2 papers reviewed); 2004 (5 papers reviewed); 2003 (7 papers reviewed); 2002 (4 papers reviewed); 2001 (7 papers reviewed); 2000 (2 papers reviewed); 1999 (5 papers reviewed); 1998 (1 paper reviewed); 1997 (1 paper reviewed); 1996 (3 papers reviewed); 1994 (1 paper reviewed); 1993 (4 papers reviewed); 1992 (2 papers reviewed); 1991 (5 papers reviewed); 1990 (1 paper reviewed); 1989 (5 papers reviewed); 1988 (7 papers reviewed); 1987 (5 papers reviewed); 1986 (6 papers reviewed); 1985 (2 papers reviewed); 1983 (2 papers reviewed); 1982 (2 papers reviewed); 1981 (7 papers reviewed); 1980 (1 paper reviewed); 1979 (8 papers reviewed); 1977 (3 papers reviewed); 1975 (2 papers reviewed); 1973 (2 papers reviewed); 1972 (6 papers reviewed); 1971 (2 papers reviewed); 1969 (1 paper reviewed); 1963 (1 paper reviewed);

In the case of *MathScinet* database, the figures are as follows: 2015 (2 papers reviewed); 2014 (10 papers reviewed); 2013 (5 papers reviewed); 2012 (6 papers reviewed); 2011 (1 paper reviewed); 2010 (10 papers reviewed); 2009 (6 papers reviewed); 2008 (9 papers reviewed); 2007 (7 papers reviewed); 2006 (6 papers reviewed); 2005 (2 papers reviewed); 2004 (5 papers reviewed); 2003 (7 papers reviewed); 2002 (4 papers reviewed); 2001 (5 papers reviewed); 2000 (1 paper reviewed); 1999 (4 papers reviewed); 1998 (1 paper reviewed); 1997 (1 paper reviewed); 1996 (2 papers reviewed); 1994 (1 paper reviewed); 1993 (3 papers reviewed); 1992 (2 papers reviewed); 1991 (3 papers reviewed); 1990 (2 papers reviewed); 1989 (5 papers reviewed); 1988 (6 papers reviewed); 1987 (6 papers reviewed); 1986 (2 papers reviewed); 1985 (3 papers reviewed); 1984 (5 papers reviewed); 1983 (3 papers reviewed); 1982 (2 papers reviewed); 1981 (4 papers reviewed); 1980 (1 paper reviewed); 1979 (8 papers reviewed); 1977 (3 papers reviewed); 1975 (2 papers reviewed); 1973 (2 papers reviewed); 1972 (5 papers reviewed); 1971 (3 papers reviewed); 1970 (1 paper reviewed); 1969 (3 papers reviewed); 1968 (3 papers reviewed); 1967 (2 papers reviewed); 1966 (2 papers reviewed); 1965 (1 paper reviewed); 1963 (1 paper reviewed);

If we summarise the results found in *MathScinet* we get another impressive facet of the scientific activity of Professor Rus, which covers more than half a century: starting from 1963, the year of his first paper reviewed, he published at least one paper per year except for the following five years 1964, 1974, 1976, 1978 and 1995.

The most productive years (quantitatively) were: 2010 and 2014 (with 10 papers each), 2008 (9 papers), 1979 (8 papers), 2007 (7 papers), 1987, 1988, 2006, 2009 and 2012 (with 6 papers each), 1972, 1984, 1989, 2001, 2004 and 2013 (5 papers each),...

So, he has been scientifically equally productive at the ages of 36 and 77!

In order to illustrate the impact and visibility of Professor Rus' publications, we present now in the following the most cited papers or books authored by him, by referring to Google Scholar, as well as to Web of Science (ISI) and SCOPUS databases.

Note that, as many of readrers know, the list of indexed papers in the two above databases is far from being comprehensive, hence the figures we present are only an approximation of the real data (that could be obtained by taking into consideration all printed materials that cannot be reached by Google or are not indexed in SCOPUS or Web of Science (ISI)).

(1) Rus, Ioan A., *Generalized contractions and applications*, Cluj University Press, 2001: **438** Google Scholar (GS) citations; **188** Web of Science (WoS) citations; **211** SCOPUS citations

(2) Rus, Ioan A., *Principles and applications of the fixed point theory*, Editura Dacia, Cluj-Napoca, 1979: **233** GS; **98** WoS; **102** SCOPUS citations

(3) Rus, Ioan A., *Picard operators and applications*. Sci. Math. Jpn. **58** (2003), no. 1, 191–219: **154** GS citations; **128** WoS citations; **119** SCOPUS citations

(4) Rus, Ioan A., Petruşel, A., Petruşel, G., *Fixed point theory*, Cluj Univ. Press, 2008: **142** GS citations; **104** WoS citations; **115** SCOPUS citations

(5) Rus, Ioan A., *Some applications of weakly Picard operators*. Studia Univ. Babeş-Bolyai Math. **48** (2003), no. 1, 101–107: **101** GS; **2** WoS; **3** SCOPUS citations

(6) Rus, Ioan A., *Ulam stability of ordinary differential equations*. Stud. Univ. Babeş-Bolyai Math. **54** (2009), no. 4, 125–133: **88** GS; **4** WoS; **59** SCOPUS citations

(7) Rus, Ioan A., Petruşel, A., Petruşel, G., *Fixed point theory: 1950–2000. Romanian contributions*. House of the Book of Science, Cluj-Napoca, 2002: **87** GS citations; **26** WoS citations; **115** SCOPUS citations

(8) Rus, Ioan A., Petruşel, A., Sîntămărian, A., *Data dependence of the fixed point set of some multivalued weakly Picard operators*. Nonlinear Anal. **52** (2003), no. 8, 1947–1959: **83** GS citations; **51** WoS citations; **55** SCOPUS citations

(9) Rus, Ioan A., *Remarks on Ulam stability of the operatorial equations*. Fixed Point Theory **10** (2009), no. 2, 305–320: **83** GS; **74** WoS citations; **64** SCOPUS citations

(10) Rus, Ioan A., *Weakly Picard mappings*. Comment. Math. Univ. Carolin. **34** (1993), no. 4, 769–773: **59** GS citations; **28** WoS; **31** SCOPUS citations

(11) Rus, Ioan A., *The theory of a metrical fixed point theorem: theoretical and applicative relevances*. Fixed Point Theory **9** (2008), no. 2, 541–559: **54** GS citations; **56** WoS citations; **51** SCOPUS citations

(12) Păcurar, M., Rus, Ioan A., *Fixed point theory for cyclic ϕ-contractions*. Nonlinear Anal. **72** (2010), no. 3-4, 1181–1187: **191** GS; **90** WoS; **101** SCOPUS citations

(13) Petruşel, A., Rus, Ioan A.; Yao, J.-C., *Well-posedness in the generalized sense of the fixed point problems for multivalued operators*. Taiwanese J. Math. **11** (2007), no. 3, 903–914: **38** GS citations; **33** WoS citations; **33** SCOPUS citations

(14) Rus, Ioan A., *Iterates of Bernstein operators, via contraction principle*. J. Math. Anal. Appl. **292** (2004), no. 1, 259–261: **37** GS; **24** WoS; **25** SCOPUS citations

(15) Rus, Ioan A., *A fiber generalized contraction theorem and applications*. Mathematica 41(64) (1999), no. 1, 85–90: **31** GS; **18** WoS; **18** SCOPUS citations

(16) Rus, Ioan A., *Metrical fixed point theorems*. Universitatea "Babeş-Bolyai", Cluj-Napoca, 1979. ii+111 pp.: **33** GS; **15** WoS; **19** SCOPUS citations

(17) Rus, Ioan A., *Ulam stabilities of ordinary differential equations in a Banach space*. Carpathian J. Math. 26 (2010), no. 1, 103–107.: **29** GS; **19** WoS; **21** SCOPUS citations.

If we sum only the citations for the 17 titles given above, we find the following impressive numbers: **1843** Google Scholar citations, **925** Web of Science citations and **1109** SCOPUS citations.

The impressive scientific activity, partially reported above, enables us to take this opportunity to cordially congratulate Professor Emeritus Ioan A. Rus on his 80th anniversary and wish him good health, happiness, the same impressive physical and mental vigour, as well as new bright results in mathematics and, last but not least, many contributions published in *Carpathian Journal of Mathematics* and *Creative Mathematics and Informatics*, the journals edited by the first author.

4. Qualitative impact and visibility

Apart from the above quantitative analysis of Professor Rus' mathematical activity, a qualitative one would be much more relevant over time. All these figures (and there is an unilateral obsession for such kind of figures nowadays) wouldn't mean too much if Professor Rus himself were not the man and mathematician of noble character that he is. Only combined with his rare human qualities could the above mentioned scientific excellence have lead to what is now the considerable set of his direct and indirect disciples and followers.

The Mathematics Genealogy Project indicates a list of 26 students (among which we are proud to be the first, respectively the last ones) and 47 descendants, many of them formed and still active around the Seminar of Nonlinear Operators (formerly Seminar of Differential Equations), whose main pillar Professor Rus continues to be.

We present now the list of his PhD students, in chronological order of the date of defending the thesis, according to *Mathematics Genealogy Project*.

(1) Vasile Berinde (1993) - 8 PhD students;
(2) Adrian-Olimpiu Petruşel (1994) - 13 PhD students;
(3) Viorica Mureşan (1997);
(4) Florica Aldea (2000);
(5) Antal Bege (2000);
(6) Adriana Buică (2000);
(7) Gavrilă Dezso (2000);
(8) Sorin Mureşan (2000);
(9) Marcel-Adrian Şerban (2000);
(10) Alina Sîntămărian (2001);
(11) Aurel Muntean (2002);
(12) Klara Baranyai (2003);
(13) Cristian Chifu (2003);
(14) Edith Miklos (2003);
(15) Szilard Andras (2004);
(16) Claudia Bacoţiu (2004);
(17) Alexandru Bica (2004);
(18) Veronica Dârzu (Ilea) (2005);
(19) Răzvan Gabor (2006);
(20) Marin Olaru (2006);
(21) Alexandrina Tarţa (2006);
(22) Edith Egri (2007);
(23) Gabriela Petruşel (2007);
(24) Maria Dobriţoiu (2008);
(25) Loredana Iambor (Galea) (2009);
(26) Mădălina Păcurar (Berinde) (2009).

All of us know that each talk of Professor Rus at the Seminar, and not only, means a fascinating journey through and above mathematics, as he can see things from that height where connections between concepts appear so clear to the few ones who reach that place.

Professor Rus has always been discovering diamonds in the rough and offering them to anyone interested to cut and polish them. Each talk contains at certain points something like "And this would be an interesting topic for a young researcher". If all the new research ideas exposed and proposed for study by Professor Rus had found someone to tackle them, then the mathematics literature would have been tens of papers richer.

Regarding the impact of the mathematical work, a dimension of this impact is given by the remarkable value of his ideas. Profesor Rus' papers are always beginnings of new research directions, awaiting for someone to understand and develop them further. Listening to Professor Rus, one feels like being part of the great mathematics, that one shaped by the great names of the ancestors, for whom Professor Rus has always shown the warmest respect. And if it comes to ancestors, we can mention, according to *Mathematics Genealogy Project*, that Professor Rus is an heir of Dumitru V. Ionescu, Édouard Goursat, Gaston Darboux, Michel Chasles, Simeon Denis Poisson, Joseph Louis Lagrange, Pierre-Simon Laplace, Leonhard Euler,...

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