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Ivan Stojmenović - A Life Well-Spent in the Service of Science

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This is a brief reflection on the life and personality of a beloved colleague, Professor Ivan Stojmenović, who left us in 2014. His achievements, his students, and the scientific and personal relationships he built will impact our community for a long time.

1 INTRODUCTION

Ivan Stojmenović died in a tragic car accident on a highway near Ottawa on November 3, 2014. His work, however will remain with several scientific communities forever. He was one of great Serbian mathematical talents, following the likes of Mihailo Petrović, Jovan Karamata, Djuro Kurepa, and Dragoslav Mitrinović.

Serbian research and mathematical education has a long tradition which developed in difficult conditions under the Ottoman, Austro-Hungarian, and Nazi occupations, as well as the communist regime, followed by the dissolution of Yugoslavia. These adversities did not diminish the creativity and hard work of mathematicians. More recently, Serbian mathematicians and computer scientists have come to world-wide prominence and Ivan was an illustration of the native talent that exists in his homeland. His contributions enjoyed wide recognition.

2 IVAN - THE RESEARCHER

Ivan was an extraordinarily gifted combinatorialist with a special talent for identifying computing problems where his insights and ingenuity could open new perspectives and generate interesting results.

He got his Ph.D. from the University of Zagreb in Croatia, but his initial work is linked to the Novi Sad and his colleague Ratko Tosić. Ivan's dissertation was in the area of multiple-valued logic, where he published over 40 papers. He studied functional completeness theory, the constructions of logical functions from a set of primitives and enumeration of bases.

Problems which were investigated by Ivan include classification of functions and enumeration of bases of a closed subset of the set of all k-valued logical functions and the study of particular kinds of functions (monotone, symmetric, Sheffer, linear, predicates, etc.) in many-valued logics. He proved there are 406 classes of three-valued logic functions, and enumerated all classes of bases, and gave an exact formula for the number of n-ary Sheffer symmetric functions (functions which can produce, by superposition, all other functions) in three-valued logic. He also investigated set-valued logic.

Early in his career, in the second part of the 80's, Ivan started a stream of publications in computational geometry concentrating on issues linked to convex hulls, Voronoi diagrams, as well as parallel programming techniques in convex geometry. Combinatorics remained a main theme of research all along, and computational aspects were emphasized: various systolic algorithms were considered (generating permutations, derangements, etc.) These preoccupations were continued in the same spirit in the 90s.

In 1995, Ivan developed an interest in computational chemistry, as witnessed by a paper on the enumeration of poly-hexagonal hydrocarbons. One of Ivan's unfinished projects was a book dedicated to computational chemistry.

Ivan brought the combinatorial techniques he developed to the study of communication networks. A paper published in 1995 in the proceedings of the MFCS conference on honeycomb networks announced a new research direction towards communication networks which lead to a huge stream of results.

In the late 90s, Ivan made new and substantial contributions in power management in wireless networks, routing and broadcasting algorithms. At the beginning of the new decade, Ivan focused predominantly on wireless networks; the previous interests were still present, but the main focus was on algorithmic aspects of communication networks. Nine of the 12 works published in 2003 are in this field.

After 2003, Ivan's major research effort was in the area of wireless and sensor networks with occasional forays in other areas such as multiple-valued logic. Between 2006 and 2014, the number of publications grew constantly with an average of 19 publications per year, culminating with 2012 when he had 26 publications.

An issue of *Wireless Communications and Mobile Computing* edited by Ivan bears as main topics "algorithmic, geometric, graph, combinatorial, and vector aspects of wireless networks and mobile computing," which very much shows the broad span of areas where his contribution had an impact.

Ivan's work had a seminal quality. Google Scholar reported recently that he had 22,907 quotations and an h-index of 74. Moreover, due to the inherent delays of paper publication, posthumous works continued to appear. According to the DBLP computer science bibliography, 13 journal articles and a conference paper were published in 2015, and six journal articles appeared in 2016.

He had worked with more than 100 collaborators and, as one of them, I can testify that working with Ivan was both a pleasure and a challenge. A pleasure, because he was a source of ideas and insights in every problem we worked on (and we have written thirteen papers together), and a challenge, because it was not easy to deal with this such persistence and energy.

3 IVAN - THE EDITOR

Ivan was a prolific and very active editor. He created several new publications and coordinated important publications in the area of wireless networks.

Three of his handbooks, "Handbook of Sensor Networks: Algorithms and Architectures" (2005), "Handbook of Wireless Networks and Mobile

Computing" (2018), and the "Handbook of Applied Algorithms: Solving Scientific, Engineering, and Practical Problems" (2018) were published by Wiley and remain best-sellers to this day. As an author of two chapters in the last handbook dealing with data mining issues, I witnessed the care and attention to detail that Ivan brought to these complicated and extensive works.

Ivan had the energy and commitment needed to initiate publications in areas in which he himself was interested. I remember the efforts we made together when the Journal for Multiple-Valued Logic and Soft Computing was started, the tribulations this publication went through when we had to change publishers and the energy and optimism Ivan invested in the journal which is now 21 years old!

Ivan created and was editor-in-chief of "Ad Hoc & Sensor Wireless Networks: An International Journal", and of the "International Journal of Parallel, Emergent, and Distributed Systems", two publications that reflected his new interest in computer networks.

Ivan served also as an editor of many international conferences: "Mobile and Ubiquitous Systems: Computing, Networking, and Services" in 2013, "Parallel and Distributed Processing and Applications: 5th International Symposium" in 2007 at Niagara Falls, "Future Information Technology" published in Lecture Notes in Electrical Engineering in 2013, ‘,"Wireless Sensor and Actuator Networks", "Mobile Ad-hoc and Sensor Networks" in 2006 in Hong Kong, and many others.

4 RECOGNITION BY THE SCIENTIFIC COMMUNITIES

For his work in communication networks and algorithms Ivan was recognized by the Institute of Electrical and Electronics Engineers, which named him an IEEE Fellow for an extraordinary record of accomplishments in data communication and wireless sensor technology. He was also a recipient of the prestigious Royal Society Wolfson Merit Award (2006) and Humboldt Research Award, Germany (2012).

He held regular and visiting positions in Serbia, Japan, USA, Canada, France, Mexico, Spain, UK (as Chair in Applied Computing at the University of Birmingham), Hong Kong, Brazil, Taiwan, China, Australia and Saudi Arabia. He was editor-in-chief of *IEEE Transactions on Parallel and Distributed Systems* (2010-2013), and founder and editor-in-chief of three journals. He was editor of over a dozen journals (including IEEE Network, IEEE Transactions on Cloud Computing, IEEE Transactions on Computers, and ACM Wireless Networks) and a steering committee member of IEEE Transactions on Emergent Topics in Computing.

Ivan was Tsinghua "1000 Talent Plan" Distinguished Professor (2012-15), a member of Canadian Academy of Engineering (since 2012), and member of the Academia Europaea from 2012 (section: Informatics), an IEEE CS Distinguished Visitor, and received the 2012 Distinguished Service award from IEEE ComSoc Communications Software Technical Committee. University of Ottawa gave Ivan the Excellence in Research Award in 2009.

He chaired and/or organized over 60 workshops and conferences, and served in over 200 program committees. He presented 34 keynotes and over a dozen tutorials. He (co)-supervised 24 PhD and 52 MSc students, and collaborated with over 160 researchers, from 26 countries. His stateless GFG (Greedy-Face-Greedy) algorithm, which guarantees delivery in a localized manner, assuming a unit graph model and accurate destination information, has changed the way routing algorithms for ad-hoc networks are being designed and has been cited over 1700 times. It has been implemented in a number of laboratories worldwide.

5 IVAN - THE FRIEND AND FAMILY MAN

Ivan and his wife Natasha built a beautiful family. He left two children, Dr. Milos Stojmenovic of Novi Sad, Serbia, who is a Computer Science professor, and Ms. Milita Stojmenovic, who is a researcher in social networks, and also a grand daughter.

I had the pleasure of enjoying the hospitality of Ivan's family, meeting Natasha, Milita, and Milos when they were very young. The warmth and friendship that surrounded will remain with me for a long time.

A moving testimonial was provided by a Canadian friend of the Stojmenovic family who was supported by Ivan and Natasha after beeing freed from Iraq, where he had been held hostage, beaten, tortured and sentenced to beheading. He wrote that the "Stojmenovics had been among the first to offer comfort to my wife and son".

Like this Canadian, I also felt that "the Stojmenovics presented as one unit. Inseparable. Strong. Proud. Ivan and Natasa were the proud parents of a pair of fascinating kids. Milos and Mila were attractive, intelligent over-acheivers with an incredible awareness of world events...and they still are."

6 WHAT IS TO BE REMEMBERED

What is amazing in Ivan's life is how much he accomplished at a high level of professionalism. Undoubtedly, Ivan was destined to be a researcher and if his

life had not ended so abruptly his brilliant mind would have produced even more significant results. He remains with us not only through his work, his former students and colleagues, but also through his personality and wisdom. The words of a former collaborator seem to be an appropriate conclusion of this homage: “Indeed, Ivan was and will remain an immensely influential researcher and a role model for scores of younger colleagues and students.”