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A BRIEF HISTORY OF MATHEMATICAL LOGIC AT THE UNIVERSITY OF NIŠ

ABSTRACT. The paper presents a brief historical overview of research in the area of Mathematical Logic and applications at the University of Niš, Serbia. We cover the period from the beginning of research in this area until 1985.

1. Introducing Teaching of Logic in Niš

The start of teaching of Logic in the region of Niš is related to the establishing of the Gymnasium in the city of Niš immediately after the liberation of Niš on December 27, 1877 from the centuries long occupation by the Turkish Ottoman Empire. Prince Milan Obrenović entered the liberated town of Niš on January 11, 1878. The Gymnasium was founded on September 27, 1878, and first students were accepted on November 20, 1878. The chronological history of the Gymnasium is presented in [1], where we find that the Logic was thought as a part of various classical courses usually provided by this kind of schools. The curriculum for the academic year 1952/53 shows that no specialized classes for Logic were offered.

The Federal Assembly of FNRJ (Federal Peoples Republic of Yugoslavia), passed on June 25, 1958, the General Law of Education including the Curriculum for gymnasia. By this law, a course *Logic and Psychology* was introduced at both educational orientations Natural Sciences and Mathematic, and Socio-linguistic The Curriculum for the academic year 1969/70 introduced by the Educational Council of SR Serbia (Socialistic Republic of Serbia) on April 23, 1969, shows that from that time the Logic has been thought as a separate course in both educational programmes, the Natural Sciences and Mathematics, and the Socio-linguistical orientation.

Teaching of Logic at a higher academic level and the scientific research in this area is related to teaching and research activities at the University of Niš that was established on June 15, 1965, and in particular at its two units, the *Faculty of Philosophy*, founded in 1971, and the *Faculty of Electronics* that started working already in 1960 as part of the Technical Faculty in Niš, within and due to the great support of the factory *Zavodi RR*, renamed latter into *Electronic Industry of Niš* (Ei). In this paper, we briefly present the work in the area of Mathematical Logic at the Faculty of Philosophy (Section 2) and the Faculty of Electronics (Section 3). In Section 4, we provide some comments about the cooperation of researchers within the University of Nisš. The presentation is restricted to the period until 1985, however, we also provide some remarks about the continuation of the work in this area.

2. Faculty of Philosophy

By a decree Number 23/1, on May 20, 1971, the Faculty of Philosophy was established at the University of Niš, and authorized to enroll 410 students on the state budget and the same number of self-financing students. In particular, the study group *Mathematics* enrolled 90 students on the budget and another 90 self-financing students. The study group *Sociology of Culture and Educations* enroled 40 students in each of these financial categories. Interestingly, in these first years of the work, the teaching of Logic at the Faculty of Philosophy was restricted to the later study group with a program of two lectures and one recital per week over two semesters. Some time later, the Mathematical Logic become a part of the curriculum in the study group Mathematics. The first lectures were given by Ljubica Sedmak under the supervision of Professor Moma Stanojević. In a period, the course was taught by Professor Aleksandar Kron, and later by Aleksandar Jovanović, who both used to travel from Belgrade to teach in Niš supporting in this way the development of the University of Niš.

In 1987 to 1998, Žikica Perović worked as a faculty at the group for Mathematics at the Faculty of Philosophy taking care of both lecturing and research in the area of Mathematical Logic. Ž. Perović received his PhD degree in 1987 by the University of Minnesota with the subject *On Cardinalities of Algebraic Structures*, and he works now at the same University. The research interest of Perović includes Boolean algebras, Orthomodular lattices, Lattices with unique complements, Ordered fields, Model theory, etc.

The group of Mathematics at the Faculty of Philosophy have developed into the Faculty of Sciences and Mathematics, and separated from the Faculty of Philosophy in 1999.

For more details about the former and present work in Mathematical Logic at the Faculty of Philosophy, we refer to the *Proceedings of the Faculty of Philosophy* and the references therein.

3. Faculty of Electronics

In the period discussed in this paper, main research in Mathematical Logic at the Faculty of Electronics was done at the Department of Computer Science by Professor Živko Tošić and Professor Lazar Djordjević, followed later by their students and associates.

Professor Tošić started the study at the Faculty of Electronics with the first generation of students enrolled at this Faculty. In 1962, he was sent with a group of students from FNRJ (Federal Republic of Yugoslavia) renamed in 1963 into SFRJ (Socialistic Federal Republic of Yugoslavia) to complete the study in Moscow, USSR, where he started his study in Mathematical Logic. The first completed research results he reported in 1965, and had first publications on the subject in 1967. In Moscow, Prof. Tošić, studied and worked under supervision of Professor D. A. Pospelov, and established a fruitful cooperations with few researchers, notably Naum N. Aizenberg, from Uzhgorod, Ukraine, and Dieter Bochmann, from Kemnitz, former GDR. The work was organized in the form of seminars and presentations by participants. The individual work and work with friends was as usually a necessary part of the students life. In 2009 a Workshop *From Algebra and Logic to Signals Neurons, and Intelligence* was organized, devoted to the memory of N. N. Aizenberg, Uzhgorod, Ukraine, August 4-5, 2009, where the former cooperation with the Faculty of Electronics in Niš, that was established exclusively due to the support of Professor N. N. Aizenberg, has been recalled and discussed.

With Professor N. N. Aizenberg, Professor Tošić worked in the area of Multiple-Valued Logic (MVL) and published also in Serbian journals as, for example, few papers in *Publications de La Faculté d'Électrotechnique de l'Université à Belgrade*. The papers submitted to this journal were communicated and reported by most eminent Serbian mathematicians at the time as, for example, Prof. Petar M. Vasić, Prof. Slaviša Prešić, Prof. Dragoslav S. Mitrinović, who was the supervisor of Tošić in the work resulting in his PhD thesis defended in 1972 at the Faculty of Electronics, Niš. A reduced version of the thesis was published as a separate issue of *Publications de La Faculté d'Électrotechnique de l'Université à Belgrade*.

Professor Lazar Djordjević started his research work as a mathematician employed at the Research Center of the factory Electronic Industry (Ei) in Niš. A brief presentation and discussion of his experiences related to research work can provide a good insight into the situation in scientific research at that time in SFRJ.

The work of Lazar Djordjević was publicly noticed after a paper on ternary logic of him was accepted for presentation at the Congress of Mathematics in Moscow in 1966. The importance of this Congress becomes obvious if we recall that the event was reported in the former daily newspaper *Pravda*, published in Moscow and distributed nationwide, that was the official organ of the Communist Party of the Soviet Union from 1918 to 1991.

The paper by Djorjdević, was a result of a broader research leading to the design of a digital adder, the production of which was proposed to the Worker's Council of Ei. A letter addressed to L. Djordjević negotiated conditions for the start of the production of the device. This research work was described in an article in the newspaper *It novine* as an example of "service of mathematics to technics" in a manner and terminology characteristic for the socialistic way of reporting about the scientific and industrial achievements.

For L. Djordjević the problems started when it was necessary to provide financial support for the trip to Moscow. The company Ei did not express any willingness to provide a grant for the trip. The case was widely commented and discussed in newspapers as, for instance, *Politika* on July 17, 1966, and *Narodne novine* on July 22, 1966, including very affirmative articles about the young scientist and his work, to aphoristic notices by the well known aphorist Jovan Hadzi-Kostić, who wrote

The mathematician Lazar Djordjević from Niš, has been invited at the Mathematical Congress in Moscow, and have collected some pittance to spend there a few days. If he were be wiser, he would try to enroll the company of football team Mladost, that also travels to Moscow, however, not at the Congress of Mathematicians. Football players do not know mathematics, however, they are very good in calculating.

In another article on the case, it was written To increase the paradox, in one of recent issues of the factory journal Ei novina (Newspaper of Ei), we can read that football players, workers of this industrial giant in our electronic industry, will most probably travel soon to the old Moscow.

Another article in *Pravda*, reporting about the Congress in Moscow, was entitled "Achievements through sacrificing" raises a question *Coincidence or Universality of Situations?*

Lazar Djordjević addressed Professor Vladimir Devide in his capacity as the President of the Committee for Mathematics and Mechanics of the Federal Council for Coordination of Scientific Activities of SFRJ. The answer, however, was that Prof. Devide, in spite

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Zgb 13.VII 1966. Bragi kolega! primili entualne kraju valjda obojica stići u Moskvu na Ja sam u Zagrebu do 19.0vog mjeseca. Srdačan pozdi

FIGURE 1. Letter by Vladimir Devide.

of his high position, had the same problems regarding participation and presenting his own paper at the same Congress (Fig. 1). It is interesting to notice practical advices by another fellow mathematician explaining possibilities of traveling to Moscow by train from Belgrade, and using the so-called tourist 20 USA\$ (the amount was allowed to take abroad at that time) to cover the cost of the stay in Moscow (Fig. 2).

Another article in *Pravda* reporting again on the Mathematical Congress in Moscow, imposes the same question about the coincidence of situations. The article stated

Most of the mathematicians (meaning the participants of the Congress in Moscow) are mainly young people. Jokes and bright minds are inherent to the young. In the today's official evening bulletin of the organization committee, it is announced that at the stadium of the "Dinamo" soccer club, it will be a match between selections of the Soviet mathematicians, participants at the Congress, and the International Mathematical Society.

In a way, the discussions about this case, appeared to actually be supportive and affirmative for Lazar Djordjević and his research work leading eventually to his nomination for a candidate for the October Prize of the city of Niš. Recall that the October Prize is a prize that was established in former Socialist Yugoslavia and related to the liberation of several cities from the fascist German occupation in 1944. It was awarded in 18 cities of

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FIGURE 2. Letter by a colleague with advices for the trip by train to Moscow.

former Yugoslavia each October to distinguished individuals, institutions, organizations, or societies, for high achievements in different areas including economy, science, art, literature, and the like. Lazar Djordjević, not only continued his own research, but also worked with students to introduce them in the scientific work.

In 1969, in the No. 3-4 of the first volume of the journal "Naučni Podmladak" published by the Student Union of the University of Niš, a paper on Boolean sets was published by L. Djordjević and Miomir S. Stanković, who was at that time a second year student of the Faculty of Electronics [5].

Further details on the scientific and teaching work by L. Djordjević can be found in an article [17] presented at the Workshop *Orthogonal Systems and Mathematical Logic*, held on March 21, 2002, that was organized at the occasion of the retirement of Professor Djordjević.

4. Cooperation of researchers within the University of Niš

At that time, it was a good practice to publish *The Proceedings of the Technical Faculty in Niš*, where the Logic was a well accepted subject. A dedication a the cover of a separatum shows cooperation among colleagues from other Departments. In this case,



FIGURE 3. The first page of an article on ternary logic in Publications by the Faculty of Electrotechnic in Belgrade.

the author, Lazar Djordjević, presented a paper to Prof. B. Danković, a colleague from the Department of Automatic.

A cooperation between the researchers at the Faculty of Electronics (Lazar Djordjević) and the Faculty of Mechanical Engineering (Života Tasić) resulted in a couple of joint papers on logic modeling of ternary memory devices. The papers were prepared in two languages (English and Russian) in parallel to provide a possibility to offer them to the reviewing procedure by experts in different research communities that were no highly communicating each other at that time.

Fig. 3 shows the first page of a paper on ternary logic published in *Univ. Beograd. Publ. Elektrotehn. Fak.*, that was communicated by Prof. S. B. Prešić, from the mathematical Faculty, University of Belgrade. The acknowledgment in the paper confirms that the author discussed the subject with Prof. D. S. Mitrinović and Prof. Ž. Tošić.

5. Research Topics at the Faculty of Electronics

In this section, we briefly discuss the main research subjects discussed at the Faculty of Electronics.

5.1. Boolean Differential Calculus. The research work in Mathematical logic and applications was also carried out in the form of seminars and individual working groups outside of the University. For instance, a seminar on Boolean Differential Calculus started in 1976, and was very active during several months, with Živko Tošić, Miomir S. Stanković, and Radomir S. Stanković, as main researchers involved in the topic. This seminar can be also viewed as a form of work with young researchers (R. S. Stanković).

The study was based on a series of publications by authors from The Phillips Lab, due to the correspondence between Ž. Tošić and André Thayse, a leading researcher in this subject.

A cooperation has been also established with Professors Dieter Bochmann and Christian Posthoff from Technical University of Kemnitz University. Some results of this cooperation lasting over two decades are summarized and reviewed in [19].

5.2. Spectral Logic. In the early eighties, Spectral Logic become a subject of research interest at the Department of Computer Science at the Faculty of Electronics. The combination of logic and spectral analysis resulted in establishing a relationship between Walsh series representations and Reed-Muller expressions for switching functions [13]. The paper was published in the journal *IEEE Transactions on Electromagnetic Compatibility* that had a special section and an Associate Editor (Henning F. Harmuth) for Walsh functions.

In 1984, due to this interest in spectral logic, a cooperation with Prof. Claudio Moraga of Dortmund University and Radomir S. Stanković was established. The cooperation resulted in, among other things, in organization of four Workshops in Computational Intelligence and Information Technologies, two summer and two autumn schools on the same subject and a few seminars in the period from February 2001 to the end of 2005. The work was organized under the auspices of the German Academic Exchange Service (DAAD) within the frame of the Stability Pact for South-Eastern Europe.

Due to his engagement and continuous support to research work in the field of multiplevalued logic and spectral techniques, Claudio Moraga was awarded by the title Doctor Honoris Causa of the University of Niš in 2006.

5.3. Word-Level Spectral Logic. Arithmetic polynomial representations as the basic example of word-level spectral representations of discrete functions are a subject of high research interest at the Department of Computer Science at the Faculty of Electronics. In that respect, a cooperation with Vladimir Dmitrievich Malyugin, from the Institute of Automatic Control in Moscow, Russia, was established in 1994. The cooperation and scientific support by Prof. Malyugin, was especially important during the time of crisis in Serbia. In 1997, Prof. Malyugin was awarded a special recognition for the Day of the Faculty of Electronics.

5.4. Multiple-Valued Logic. Research in Multiple-valued logic that stared already in the late sixties, has been continued until the date especially in connection with applications of spectral methods in this area. It can be noticed that, at the International Symposium on Multiple-Valued Logic (ISMVL) in 1978 a "Selected Bibliography on Spectral Logic" compiled by M. G. Karpovsky was presented, where papers by L. Djordjević, R. S. Stanković, and M. Stanković were included.

At the ISMVL in 1984, held in Winnipeg, Canada, it was presented for the first time a paper by authors from former Yugoslavia [15] at these symposia that are continuously organized by IEEE starting from 1970. The work in this area has been influenced by other researchers in this area in Serbia. In particular, the influence by Coriolan Ghilezan, and his work summarized in the paper [18] is obvious in the paper by R. S. Stanković [16].

Since hosted by the Faculty of Electronics in Niš, research in binary and multiplevalued logic, has been directed also to applications in computer engineering, see, for instance, [14] for early works in this area.

The multiple-valued logic is a subject of continuous research interest at the Computational Intelligence and Information Technologies (CIIT) Lab at the Department of Computer Science, the Faculty of Electronics.

6. Closing Remarks

Research in Mathematical Logic at the University of Niš started in the early sixties at the Department of Electronics within the Technical Faculty. The work in this area continues at Group for Mathematics at the Faculty of Philosophy, and at present the Faculty of Mathematics, and the Department of Computer Science, the Faculty of Electronics. The topics of interest explored at the Faculty of Mathematics include Boolean algebra, Ordered fields, Model theory, and others.

Research interests at the Faculty of Electronic are mainly related to polynomial representations of binary and multiple-valued logic functions, Boolean differential calculus, Multiple-valued logic circuits, both combinatorial and sequential, Spectral logic, and their applications in various areas of Computing. The bibliography presents just a brief sample of related publications until 1985.

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